

# Evolution of the Spatial Types of Wuhan Urban Congregated Housing from a Public/Private Space Perspective (1949–1966)

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**Abstract**—Modern urban housing in China has its own development path and distinctive spatial forms under the influence of China's socialist political and economic system. It thus contains its complex and specific public/private relationship dimensions. The present study focuses on analyzing the spatial types of congregated housing in Wuhan through cases from 1949 to 1966 and exploring how their residential spaces participate in shaping the social public /private relations of the nation, society, individual and family in the same period by constructing the spatial relations among the city, residential area, residential building and domestic space. This study may help to enhance understanding of the intricate and dynamic relationships between public and private spaces in Chinese urban housing of the time, which differ from their counterparts in Western cities. It also provides an enlightenment on research on public/private spaces in current urban housing in varied contexts.

**Index Terms**—urban congregated housing, public/private space, collective space

## I. INTRODUCTION

Between the 1950s and 1970s, Western reflections in the fields of society, politics and urban construction stirred discussions about the public domain and urban public spaces [1-3]. As the theoretical exploration of the dual concept of 'public/private' went on, the private domain and private spaces as a set of systematic subjects entered researchers' field of vision. Residences for families were thus studied from a new perspective, i.e. as an architectural type representing private spaces. Among relevant studies, some studies have focused on revealing the privacy of domestic spaces, concluding that the selection of residential space mode, domestic design and renovation is closely related to personal experience, vision, family relationship development and self-identity [4]. Some find a 'intimacy gradient' in family residences to support the internal and external communication needs at different levels of families [5]. Others find that rooms as private spaces play an important role in subculture and public life, so they have public/private duality [6].

Conversely, multi-family housing, which started in the urbanization process of Paris in the late 18th century, developed into modern congregated housing in the middle 19th century. In this setting, the living spaces of multiple families are integrated into one building through professional design and connected/separated by a common space or facilities. The most important feature of congregated houses is that they break the independent domestic space model of traditional residences and integrate public and private spaces into one building. Consequently, its emergence aroused discourses about public/private space relationships. For example, Sharon noted that the continuous, permeable and reversible relationship between apartments and urban public spaces in Paris in the 19th century reflects the potential ideology about public/private life in the society [7]. Gwendolyn analyzed the impact of the socialised and centralised household service space and operation in American premium apartments on the private life and living space of families [8]. Lynne described the conflict between the apartment as a residential type that originated from the private life concept of the Western Bourgeois class and Soviet political ideology in the Soviet socialist period [9].

To sum up, the social life in the modernisation process complicates the publicness and privateness of residential spaces, and modern congregated houses in their public/private space integration action, especially deepens the dialectical relationship between the binaries, i.e. conflicting and collaborative. Moreover, modern congregated houses produce different variants in different social backgrounds as a result of the mutual production between social relationships and living spaces.

After the foundation of the People's Republic of China, modern congregated houses gradually became a main type of housing. Then, it got its own development path and distinctive spatial forms under the influence of China's socialist political and economic system. Lv systematically combed that phase of history [10]. However, he only emphasized the impact of the macro-political and economic context on the technical and economic conditions of residences and the residential functions and spatial layouts under the corresponding restrictions. He did not realize and study from the perspective of the relevant theoretical issues of social and

political sciences, and an analysis of the ‘translation’ of ideology, social relations and social structure by architectural forms was absent. Based on this literature review, the present study explores the plane layout types of congregated houses in Wuhan from 1949 to 1966 from the perspective of sociological public/private relationships. It presents answers to ‘what are the layout characteristics of residential space in different stages of 1949–1966’ and ‘how did residential space participate in shaping the social relations of the nation, society, individual and family in the same period by constructing the spatial relations among the city, residential area, residential building and domestic space.

## II. RESEARCH FRAMEWORK AND METHODS

The emergence of public/private space discourses is related to the public/private domain theoretical issues in Western sociology and politics. The latter focuses on the power and interest relations between the state/society and individuals/families in social organisations and social governance. From a social perspective, it involves social equity and justice, while from a personal perspective, it is related to the development and well-being of individuals. A physical public/private space is not only a projection of social public/private relationships but also an important means of shaping public/private relationships [11]. The investment, construction, ownership, spatial form and spatial use of modern congregated houses contain complex public/private relationship dimensions, so a public/private space in a pure and absolute sense does not exist. In addition, modern congregated houses often contain a hierarchy from a household, building to a block and so on. Hence, constructed public and private spaces are not two separate poles but two spatial levels with relativity, and different residence types have different hierarchies. This study only focuses on the spatial forms of residences and suspending factors, such as residential ownership and spatial use, taking household space units in design and construction as ‘private spaces’ in the usual sense and taking common spaces outside households of different scales, different ownership forms and different uses as a series of public spaces with different publicness. Based on this concept, the author of this study explored the formal relationship between public and private spaces constructed under different scales of residences. Then, the causes according to the social organisation and governance structure and family relationship in the corresponding stage are explained. The specific analytical scales and contents are as follows:

At the city scale, the relationships between residential areas and urban and working public spaces are mainly analysed. The relationship between residential areas and urban public spaces represents the opportunities for individuals to participate in a wide range of social activities or individuals’ dependence on urban social public services. It also indirectly represents the openness, heterogeneity and vitality of urban public spaces and social domain, excluding state institutions and the structure of social governance. The relationship between residential areas and working spaces is also one of the

important dimensions of sociological public/private relationships. By contrast, the universal disintegration of the household economy since the beginning of the 19th century—as one of the signs of modernity—led to a separation between work and life so as to produce the division of the rational public domain and emotional private domain. On the other hand, from the second half of the 19th century to the beginning of the 20th century, practices, such as social utopia, company towns or socialist farms, all linked work with living spaces, reflecting the intention of integrating private life into collective life though their purposes, scales and degrees of collectivisation varied [12,13].

At the residential area scale, the major concerns are the forms of residential areas and configuration modes of public facilities. The self-sufficiency or exclusivity of living spaces within a residential area is reflected in the openness or closure of the residential boundary and public space and facility configuration. Furthermore, the hierarchy between public and private spaces in a residential area is reflected in the form composition of internal space. The above-mentioned aspects provide a material basis for the formation of the common subjectivity of a community and the hierarchy, homogeneity or heterogeneity within a community.

At the building scale, household units together constitute a building. Moreover, the internal shared space and facilities of a building not only serve each household but also lay a spatial foundation for neighbourhood communication. The formal analysis mainly focuses on the formal characteristics of buildings, relationship between a common space and the household unit, types of common spaces and number of common users.

At the domestic space scale, firstly, the self-sufficiency of a household space, which is the guarantee of the ‘privacy’ of family life, is analysed. Second, the internal spatial configuration of a household space and the formal characteristics of an internal space are analysed to reveal the influence of external social and political forces on the internal relationship and concept of the life of families.

The object of this study is the Wuhan urban congregated houses built between 1949 and 1966. Since 1949, Wuhan, as the most important city in central China, has been a test field of national policies. Under the unified management system of the central government, the urban life development in Wuhan has kept the same pace as the central policy. Hence, the development of Wuhan housing types is representative to a certain extent of China.

The type determination and case selection in this study are based on an information comparison between the literature and fieldwork. Although the factors affecting the types of residential spaces are extremely rich [14], China’s highly centralised socialist economic and political system was the main driver for residential developments in 1949–1966. Therefore, the selection of residential cases in this study was firstly based on the *Annals of Wuhan Real Estate* [15] and the *Urban Construction Annals* [16] published by the government in the 1980s, as well as other relevant theses [17] [18].

Secondly, a field investigation (narrow investigation) was conducted. The urban core development area of Wuhan, which became a modern city foundation before 1949 and continued to develop after 1949, was taken as the comprehensive collection area of type samples, with the residential areas of relatively simple nature produced by specific policies at different historical stages supplemented appropriately. Some of these areas are the Wuchang Shahu workers village area that the government began to intervene in the early 1950s, the Honggangcheng residential area built for a national key project of the '1st Five-Year Plan' and the Jiefang Avenue trunk road residences developed in the new urban trunk road expansion projects in the early 1960s. We finally considered 16 cases, including nine literature cases (a total of 12 cases are involved in the literature). As of 2020, only six cases—1, 4, 7, 8, 12 and 13—survived urban renewal; three cases—2, 5 and 6—were acquired from documentation and residents' dictations.

Cases 3, 9, 10, 11, 14, 15 and 16 cases were found in the fieldwork.

### III. SPATIAL TYPE ANALYSIS FROM THE PUBLIC/PRIVATE SPACE POINT OF VIEW

Based on the social background of China and the residential construction situation in 1949–1966, the 16 cases were divided into two stages on time. Firstly, in 1949–1952, the state invested a small amount in Wuhan's residential construction and adopted a new democratic residential policy in the city [19]. Second, in 1953–1966, Wuhan housing development became a part of the national economic plan and also a part of the socialist public ownership system construction. The preliminary-type analysis under different dimensions and scales by stage is shown in Table I.

TABLE I. SPATIAL TYPE ANALYSIS OF 16 CASE

	Time, Name of project	Owned By, Used by	Location	Urban facility or service	Residential area type	Internal supporting facility	Residential building type	Modular space unit type	Common space in a modular unit	Household space unit type
1	1952 Heping li	Government, clerks	Core area in old city	relatively complete, depend on market	Open lifen type	none	Modular type	Central staircase Type	Vestibule, Hallway, S,K,T	Single room type
2	1952 Shahu worker' village	Government and private enterprise, workers	Existing living area near the factories	A few, but inadequate	Open lifen type	Public toilet, public tap-water point	barrack	none	none	Suite(2 rooms and K)
3	1952 Minsheng residence	Private enterprise, clerks	Core area in old city	relatively complete, depend on market	Gated courtyard	Guard room, garden	Modular type	Central staircase Type	Vestibule, staircase	Self-contained apartment
4	1954-1957 Wugang residence etc.	State enterprises or institutions, Danwei staff	Suburban, new industrial districts	Lack. Planned collective services develop gradually	Danwei Jiefang type	Relatively complete, exclusive	Modular type	Central staircase Type	Vestibule, staircase	communal apartment
5	1956 Wuhan Youdian residence	Municipal enterprise Danwei staff	Urban old area	Limited, runed by planned collective enterprises	Traditional block; mixed use, permeable	none	Integrated type	Gallery type	Common gallery, S,K,T	Single room type
6	1957 MBCI	Municipal institutions, Danwei cadres	Urban old area	Limited, runed by planned collective enterprises	Danwei dayuan type	Canteen, Public toilet	Integrated type	Gallery type	Common gallery, S	Self-contained apartment
7	1958 MCBI	Municipal institutions, Danwei staff	Urban old area	Limited, runed by planned collective enterprises	Danwei dayuan type	Canteen, Public toilet	Integrated type	Gallery type	gallery, S, without K&T	Single room
8	1961-1963 Jiefang Avenue, Jinhua Cun	City housing Authority, Danwei staff	Urban new trunk road expansion project	Lack. Planned collective services develop gradually	Along the trunk road, open residence area	A few, but inadequate	Modular & integrated	Small courtyard type	Gallery, courtyard, S,K,T	communal apartment
9	1961-1965 Jiefang Avenue, Xinjiadi	City housing Authority, Danwei staff	Urban new trunk road expansion project	Lack. Planned collective services develop gradually	Along the trunk road, open residence area	A few, but inadequate	Modular type	Small courtyard type	Gallery, courtyard, S,K,T	Single room type
10	1962 Shengli street	City housing Authority, Danwei cadres	Core area in old city	Limited, runed by collective enterprises	A building with a closed courtyard	Courtyard Special case	single unit	Central staircase Type	Staircase,	Self-contained apartment
11	1965 Wuhan instrument plant	Municipal enterprise Danwei workers	Urban old area	Limited, runed by collective enterprises	Traditional block; mixed use, permeable	none	Integrated type	Gallery type	gallery, S, T	Single room with separated kitchen
12	1962-1966 Wuhan leather cooperative plant	Collective enterprise, workers	Urban old area	Limited, runed by collective enterprises	Traditional block; mixed use, permeable	none	Integrated type	Gallery type	gallery, S, K,T	Suite: 2 rooms without k & T

(S. staircase, K. kitchen, T. toilet)

#### A. Three Differential Public/Private Spatial Relationships (1949–1952)

##### 1) Different degrees of dependence on urban public spaces

At the city scale, the three cases from 1949–1952 relied on the old city or built settlements to select sites to varying degrees, and the opening degree of the boundary and external environment of different residential areas were varied. Case 1 adopts a 'Lifen' variant layout (a Wuhan traditional type of low-rise high-density row

layout). The roads are connected with an external urban space; there are no public facilities inside and the surrounding urban public buildings and facilities are relatively complete, including commercial, medical and office buildings, schools and markets. Case 2 is open, but there were few urban public service facilities around back then; daily necessities, such as grains and vegetables, were sold on markets spontaneously formed by surrounding farmers and individuals. Case 3 adopts a closed courtyard layout, with a clear boundary with the urban public space. However, due to a limited scale, it

still maintains effective contact with the surrounding urban public space.

All three cases are located close to the corresponding working spaces, but they still depend on a transition of the urban public space. These characteristics allow the life of residents to remain private.

At the residential area scale, the three cases are different in the internal public space structure. Case 1 has a balanced layout, but the residential buildings are arranged face to face, forming landscape roads serving the fronts of residences (lobbies)–public space with strong publicness and living roads serving the backs (kitchens) of residences–public space with weak publicness. In case 2, there is no road differentiation, and public toilets and tap water stations are concentrated places for community public activities. In case 3, the spaces in the courtyard are divided into spaces with different publicness, front and back, inside and outside, and echo the residential hierarchy.

## 2) Private spaces with different privacy levels



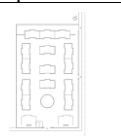

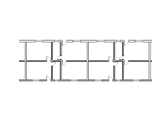

At the building scale, in terms of the modes of multi-domestic space integration in the three residential buildings, case 1 and case 3 are of modular type, producing common spaces. Case 2 is the terrace type, with almost no available common space, but household doors are directly connected to the road of the residential area. Hence, there is no transition between the private living space and public space in the area. In terms of the residential unit, the common spaces of case 1 include a public foyer, public staircase, shared kitchen and toilet and shared hallway. On the one hand, such spaces provide a spatial basis for neighbours' communication. On the other hand, because six households per floor share limited and necessary living spaces, neighbourhood conflicts are unavoidable. Case 3 only offers a shared staircase, and the number of users is 1–2 households per floor. The shared space is just for traffic, so neighbours' communication has a clear boundary and conflicts incurred from common use are limited.

At the household scale, case 1 is a single-room type with poor self-sufficiency. Case 3 is a self-contained apartment type with high self-sufficiency, so privacy is guaranteed. Case 2 is a suite type. Although there is a kitchen, there is no water supply and no toilet, and residents depend on the public toilet and water supply station of an area located dozens of metres from home. Thus, the privacy of the household space is not high.

These three limited cases show that in the first three years after the founding of the People's Republic of China, the society generally held that living depends on the urban public space and that living services depend on the supply of the social market. Moreover, the living place should be close to the working place, but work and life still belong to separate public and private spaces, which is the embodiment of the general development law of modern urban life on the types of urban housing in Wuhan. At this time, the differentiation of residential types in Wuhan mainly stemmed from the class differentiation caused by the law of the market economy and reflected the concepts of different groups on the

public/private space relationship: In case 1, the domestic space of government staff has poor privacy. In case 2, workers' housing features not only limited external urban public space development but also non-self-contained internal private space and blurred the separation of public and private spaces. In case 3, intermediate and senior staff can better realise the separation between urban public space and private residential space and the hierarchy of internal living. The residence enjoys not only the publicness of the external urban space but also the privateness of the internal living space. (Table II)

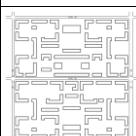


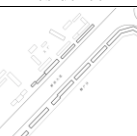



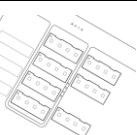
TABLE II. HOUSING TYPE (1949–1952)

Case 1 Lifen variant Single room	Case 2 Lifen :barrack suite	Case 3 Gated courtyard apartment
		
		

## B. Blurring of the Boundary between Public and Private Spaces (1953–1966)

### 1) Deurbanisation and collectivisation of public spaces. (table III))

TABLE III. RESIDENTIAL AREA TYPE (1953–1966)

Case 4 Danwei Jiefang	Case 10-11 Danwei Dayuan	Case 9 Traditional block	Case 12 Trunk road residence
			
Case 8 Jiefang variant	Case 14 small courtyard	Case 16 Traditional block	Case 13 Trunk road and xiaoqv type
			

From 1953 to 1966, the most important type of residential area was the supporting living areas of newly built enterprises/public institutions (Danwei) located on the edge of the city, such as in cases 4–8. The newly built areas adopted a block type and later adopted a neighbourhood type, but the common point is that life service facilities were invested by respective employers or the city housing authority. Hence, they belong to their respective exclusive residential areas and are independently managed by enterprises/public institutions. Thus, they can be called an 'institution-based block type' (Danwei Jiefang type, such as case 4–8) or 'institution-

based neighbourhood type' (Danwei Xiaoy type, such as case 13). Therefore, on the one hand, residences' private space and private life are fully included in the paternalistic collective governance by state-controlled institutions, reducing privacy. On the other hand, as the urban public space lacks substantive life content and social participation, publicness is also reduced. For example, cases 4–8 are all close to factory areas. Although residential neighbourhoods are relatively open, without boundary walls or access control, they actually belong to the internal buildings of institutions. There are no urban public buildings on the streets, so they do not have urbanity. In addition, residential layouts mainly highlight the exclusive internal 'public buildings' and 'public courtyards', and broadcast loudspeakers synchronised with the factory area are equipped. Hence, the public space inside each residential area is also collectivised.

In the old urban area, new housings are extremely limited, and they generally belong to non-key state-owned institutions, such as handicraft cooperatives and subdistrict factories serving socialist transformation. Wherever available, the courtyards of institutions (Danwei Dayuan type) are still the main form of residential spaces, such as cases 10–11, which are two residences in the courtyards of a subordinate to the Chemical Industry Bureau. However, the supporting facilities of courtyard-type residences in the old area are limited by space, so residents are still dependent on the urban public space outside the courtyard.

In addition to the institution-based neighbourhood type and courtyard type, there were a few detached houses directly open to blocks, such as cases 9 and 16. However, as the 'institutional system' was comprehensively established and the city shifted from a consumption-oriented city to a production-oriented city after 1956, the urbanity of the external environment of residences was gradually weakened. Specifically, urban public service facilities were insufficient, and the richness of urban public life was reduced. In this context, the public/private life of workers in the old city was less supported than that of workers of key enterprises in urban suburbs.

In addition, in the early 1960s, the government opened up Jiefang Avenue and Zhongbei Avenue and built residential communities along the roads to change the pattern and appearance of the old city, such as case 12, which became a new type. This type of housing enriched the urban public space, with the commercial space arranged on the ground floor. However, due to the contradiction between the prevailing socialistic planned economic system and commercial consumption attribute of the city, this type of housing was not promoted and the urbanity of housing was always suppressed.

At the residential area scale, the layout forms of residences are mainly for highlighting the memorial and orderly properties of external public spaces, which is well represented in case 4. Besides, residential buildings are designed by a handful of standard house designs and 'united household' distribution modes. Hence, private spaces in these buildings are only differentiated in

the size and number of rooms but not in the hierarchy of spatial locations.

## 2) External structuralisation of private spaces

At the building scale, influenced by the Soviet Union, the unit-combined (modular) design and self-contained household unit became the type of housing promoted by the government after 1953, such as cases 4–8. However, this is only a formal representation because each self-contained unit is assigned to 2–3 families by the actual allocation standard (4 m<sup>2</sup>/person). This phenomenon is interpreted as a contradiction between long term and short term or 'reasonably designed, unreasonably used' [20]. However, in fact, this is a contradiction between the national plan and ideal—reducing investment in living consumption and solving the living problem of all people in an equalised way—and private life. However, the government still adopted this modern type of housing. This type of housing was originally designed to represent private life in the context of high urbanisation. It turned out to be a tool for making neighbourhood relations structured and orderly due to the following reasons: At the household scale, a household space only consists of 1–2 isolated rooms, and two or three households live behind one door. This type of space is called 'a united household (Tuanjie Hu)', which shares a kitchen, a toilet and partitions with poor sound insulation. Two to three united households form a storey-based residential unit; four to five residential units form a building; four to five buildings form a half-open-half-closed courtyard; multiple courtyards constitute a neighbourhood. This spatial logic and 'unit' match the structure of resident governance. The corresponding 'courtyard', 'building', 'residential unit' and 'united household' are each assigned with persons in charge, responsible for responding to the call of superiors to organise various activities, such as sanitation activities, policy publicity, patriotic action, anti-illiteracy campaign, advancedness evaluation, mutual help and assistance, class struggle and supervision and disclosure. Through this structure, political life precisely reached each family. As a result, a single family had no spatial barrier to protect its independence, self-sufficiency and privacy.

## 3) Lack of privacy in private spaces

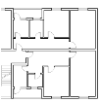








In 1956, the construction professionals reflected on a 'united household' housing design and proposed 'small-area housing' [21], hoping to achieve single-family self-contained apartments under the limitation of national economic standards. The gallery type is exactly a product under this background. However, in the end, this type of housing still proved 'beyond the standard' under the 'strict economy' policy, so it was not promoted. Thus, fundamentally, the ideological restriction on private life and private spaces is the reason for the popularity of 'united household' housing (case 4-8,12). A small number of single-family apartments became the residential form of cadres—a new political elite class after 1956, such as cases 10 and 14. However, although such a small-area self-contained single-family apartment ensures the life independence and privacy of residents to some extent, it still lacks structured characteristics inside. For

example, in cases 4, 10 and 14 and other residential designs of the same period, there is no differentiation between a family-shared space and individual space within a house. Instead, we see only a connection or arrangement of rooms in unfixed principles and rooms are not graded by primary/secondary, size, orientation or privacy. The design studies during the same period focused on the bed space in each room (generally more than two beds), never mentioning family reunions, enjoyment/cultivation of subjects or other issues about the domesticity, personality and privacy of private spaces.

Different from combined/self-contained apartment houses, single-room houses with an exterior gallery, an interior gallery or a courtyard (cases 9, 11 13 and 15,16) were more common and served as the actual residences of most workers at that time. Their private space was not self-contained and even connected with a common corridor or well with a high degree of sharing, traffic concentration and visual transparency. One kitchen was shared by 3–4 families and one toilet by 8–19 families, so private life and public life were often intertwined.

To sum up, in 1953–1966, privacy was consistently lacking for self-contained apartment houses, ‘united household’ houses (semi self-contained apartment houses) and single-room houses. (Table IV)

TABLE IV. HOUSING TYPE (1953-1966)

Self-contained apartment Case 4,10,14			
Communal apartment Case 4,8,12			
Single room type Case 9,13,14			

#### IV. CONCLUSIONS

In 1949–1952, the Wuhan government, in the face of the shortage of urban housing, had not yet clearly determined urban housing as an important part of socialist transformation and had no definite intervention in the forms of urban housing and daily life. Then, residential types partly continued the traditional types before 1949 and were graded by economic classes. They embodied the conceptions of different classes about public/private space relationships.

After 1953, Wuhan established a socialist planned economy system based on public ownership. Housing construction, as a part of the national economic plan, naturally became an important means of comprehensive political intervention in daily life. In the social nationalisation context, the differentiation between the

public domain and private domain with modern significance was replaced by the unified collective subject. Residential design, construction, distribution, maintenance and service were all controlled by the government and the ownership of housing completely belonged to the state or state-owned enterprises/institutions. The public/private space relationship reflected in the form of housing was correspondingly blurred. That is, at the city and residential area scales, the publicness of urban public spaces was weakened and the public space of a residential area was collectivised. For private spaces, self-contained apartment housing was changed into united household housing as a way to structure private spaces. Small-area self-contained apartment housing was only lived by the minority of cadres, and care for privacy was still insufficient. For the majority of ordinary staff and workers and staff of non-key institutions, single-room household spaces were the most common form and the privacy of such spaces was seriously lacking. In short, the public/private space constructed by congregated houses was unified by ‘collectivity’ to meet the needs of collective life advocated by the state.

In conclusion, between 1949 and 1966, the evolution of spatial types of Wuhan residences was essentially reflected in the change in public/private spatial relationships. Its development path is consistent with the social relationship transformation and development direction led by the Chinese government. This factor is exactly the difference between Chinese and Western residential types.

The shortcoming of this study is that we need to further consider the daily life of residents in the residences presented here and investigate the conflicting/adaptive relations between space design and use. With this research direction, we can further understand how residents exerted their subjectivity to domesticate or privatise their living space in a collective residential space driven by a strong social trend, especially in residential spaces with fundamental ‘state publicness’ dominated by the state.

#### CONFLICT OF INTEREST

The authors declare no conflict of interest.

#### AUTHOR CONTRIBUTIONS

I wrote the paper and drew all the plans of the cases. The plans of case 2 were referenced from reference [17], and case 10,13 from reference [18]. Besides that, all the plans were drawn based on fieldwork conducted by Yaoyao and I.

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