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Comparing Characteristics of Environmental Behaviors and Spatial Types in Open and Gated Housing Blocks: A Case Study of Changchun, China

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Abstract: Physical characteristics of residential areas affect many aspects of living sustainability, including the environmental behavior of residents. Based on the policy issued in China in 2016, the guideline of transforming existing gated housing blocks into open mode is being gradually implemented in some cities. However, the transforming of boundary walls and internal roads has changed the living environment such as the open space that residents have been accustomed to and has affected environmental behaviors correspondingly. From perspectives of spatial types and environmental behaviors, this research compared an open housing block (which is reconstructed from gated one) with a comparable original gated housing block. The Behavior Mapping Method was used to capture environmental behaviors in two housing blocks; factor analysis and cluster analysis were used to extract spatial characteristics and classify spatial types; and finally differences between the open housing block and the gated housing block were shown by comparing the distribution of environmental behaviors in each space type. The results indicate that the presence or absence of the enclosing walls affects the division of space types and environmental behaviors in housing blocks. For gated housing blocks, spaces with strong privacy attract various types of activities, which are overwhelming in categories and the number of people, while in the open housing blocks, this situation is not as obvious as in the former.

Keywords: housing blocks; reconstruction; environmental behaviors; spatial types; China

1. Introduction

1.1. General Context and Its Peculiarities

China's urbanization rate has increased from 17.92% in 1978 to 57.35% in 2016 [1], which was also accompanied by massive housing developments and continuous growth of urban traffic pressure [2–6]. The gated housing block has also been developed in this background and has become the dominant residential form in China. This kind of blocks covers a large area and is usually zoned by urban arterial roads, whose lengths are 300–500 m. It is isolated by bounded walls, fences, plants, gates, guard houses, etc., and has certain shared community facilities and internal roads inside. The wide existence of this kind of housing blocks has caused some traffic problems such as limited connectivity and low density of road network [7,8]. Because of this state, the central government of the People's Republic of China released a guideline in February 2016 to address "obvious issues" and "urban ills", such as making traffic networks intensive and unclogging the urban roads by two main approaches: (a) promoting open housing blocks with small areas among newly-built residential areas; and (b) reconstructing gated housing blocks by removing bounding walls and connecting internal roads with urban roads [9].

After the guideline was promulgated, the part of transforming residential type immediately ignited the topic and became a domestic focus.

1.2. The Purpose of this Work and Its Significance

As mentioned above, this guideline is traffic oriented, while the contents towards residential type in it, especially towards the existing gated housing blocks, may bring unexpected impacts on residents' lives such as social interaction and places of it due to the change of space features [10–13]. The residents have been accustomed to gated housing blocks for a long time; this traffic oriented transforming of boundary walls and internal roads has changed the living environment, and might affect environmental behaviors of residents correspondingly. Since there will be a lot of reconstruction throughout the country, it is necessary to understand what this effect is. As the impact from architectural and environmental behavior aspect is still unclear, this research attempted to reveal the influence of spatial transformation on outdoor behaviors of residents. Meanwhile, it also aimed to point out in which type of outdoor spaces that residents are affected. These aims were pursued through crosswise comparison between open housing blocks and comparable gated housing blocks. After studying and understanding these effects qualitatively and quantitatively, we could put forward reasonable suggestions for following extensive transformation in China.

1.3. Research Status

In the two years since the policy was enacted in 2016, some researchers, national press and local news report have also responded to the question. From the sociality and the policy level, they have combed the development of the closed block and the possible impact of the transformation [14–16]. Experts from the China Urban Planning and Design Research Institute and the National Development Reform Commission have also largely expressed their support. In their opinion, the reforms would help to transform Chinese cities into "truly modern ones that are open and defined by their public places and services" [17] (Xinhua News 2016b).

While on the other side, some researchers are still skeptical of this massive reconstruction, and the reform guideline still faces many problems of policy enforcement and legal contradiction. As of December 2016, the guidelines have been deemed to be policies at the party and state levels. According to the Supreme Court of the People's Republic of China, the reforms would still have to be legalized because they implicate property rights issues related to the affected owners and business operations [18] (Li 2016). Some experts have suggested that there ought to be a transition phase to prepare and implement complementary policies that would address the potential tensions arising from the guidelines [19] (Guangzhou Daily 2016), and the complementary policies should relate to property management, security and property rights, as well as the planning and allocation of public amenities and services [20] (Han and Wang 2016). Kan argued for more tempered, light-handed approaches and cautioned against a complete rejection of the superblock [14]. The Vice-Minister for Housing and Urban-Rural Development clarified that the initiatives to "open up" existing enclosed neighborhoods and work unit compounds were "not intended to remove their walls", but to "open the gates" instead [21] (Wu 2016a). Although the clarification itself is still somewhat vague, it suggests that the new guidelines will not necessarily usher in the end of gating as a practice.

However, in many cities, reconstruction of existing gated housing blocks has already begun and has been completed in some places. The authors conducted screening and sampling of cities in China prior to April 2017, involving open housing blocks and reconstructed gated housing blocks, and found different phases of reconstruction in Beijing, Chengdu, Zhengzhou, Changchun, etc. It cannot be neglected that the physical conditions and space environment of closed residential areas have been transformed already. Therefore, it is necessary to explore the impact of spatial transformation on the environmental behavior of residents after transformation.

1.4. Controversial and Diverging Definitions

To understand the definition of "gated housing blocks" and "open housing blocks" more accurately, a similar concept, gated communities, needs to be clarified.

Chinese scholars have been using the same term "gated communities" to refer to gated private housing developments in Chinese cities [6,22–24]. At present, there is no exclusive fixed definitions of gated and open housing blocks in China in academic circles and design codes. Some concepts are borrowed words, such as "gated communities", "closed communities" and "enclosed communities", while due to the translation they are apt to be mixed and confused. The term of gated communities described in "Fortress America" has certain differences with Chinese gated settlements.

Different from the suburban island distribution in United States, Chinese gated housing blocks exist in various districts of cities. With diverse prices, this kind of gated communities served all social classes. Moreover, on the scale characteristics, most Western gated communities have the characteristics of small scale and low density, while, in China, more gated housing blocks have the characteristics of large scale and high density. From the closed degree, gated communities are often wall distance, taking strict security measures, and need identification to enter residential areas. Chinese gated housing blocks are mainly isolated from low walls, fences or green belts, and might be equipped with guards [16]. As above, the socioeconomic connotation of gated communities in the US is not applicable to many gated housing complexes in Chinese cities including private housing complexes for low-medium income households (affordable housing), work-unit compounds, and traditional housing complexes [22]. In other words, "gated housing blocks" in China is a broader concept than "gated community" in the US, and it emphasizes more on the physical form of enclosure, not the legal and social aspect.

The "gated housing blocks", a spatial concept, is defined as a China-typical residential quarter in this study. It is written as gated housing blocks to correspond with the "open housing blocks". Based on the guideline issued in February 2016, the definition of open housing blocks comes to describe another category of residential areas: without boundary walls, and internal roads of open housing blocks connect with urban roads for public use. The opinions attempt to promote two kinds of open housing blocks: newly-built open housing blocks and reconstructed housing blocks from the gated. Since few newly-built open housing blocks have been founded, it mainly refers to reconstructed type in this research.

2. Materials and Methods

2.1. Identification of Case Studies

By April 2017, Beijing, Shanghai, Changchun and six other cities were reported to promote open housing blocks after the opinion was issued, yet most of these cities only stay on the propaganda level and have not begun to implement construction or reconstruction. Changchun city, located in north of China and the provincial capital of Jilin province, is chosen as the research area for this study by screening and sampling because of the following reasons: 155 housing blocks have been completed reconstruction to open from gated, covering many districts and involving comprehensive categories especially the most general category of residential patterns in China. All these characteristics make Changchun a good sample to represent typical region of China cities for learning the transforming of housing blocks.

Compared with five other districts in Changchun city, Lvyuan district was selected to be the survey area due to the appropriate quantity and categories of housing block reconstruction. After a one-week observation in this district, CHANGKEB and QICHECHANG34 were randomized to be comparable experimental and control groups, as these two sites have a lot in common. CHANGKEB, the reconstructed open housing blocks, is abbreviated as CKB. The gated housing block, QICHECHANG34, is shortened to be Q34 later. The location of cases and the detailed characteristics are shown in Figure 1 and Table 1.

The open housing block CKB and gated housing block Q34 in this paper belong to the Changchun Bus Factory and the Changchun First Automobile Factory, respectively, which are the unit settlements for employee in the two factories. Changchun Bus Factory and Changchun First Automobile Factory were established in 1954 and 1953, respectively. They are the heavy industrial bases that China's

first five-year plan had focused on and have developed rapidly since the reform and opening up in the 1980s. The two existing settlements were built during this period: CKB in 1988 and Q34 in 1985. They are not only similar in socio-economic context, but also have common physical features such as location, area, construction age, building layers, etc. (Table 1). This similarity excludes many other factors besides openness, making them highly comparable for this study.
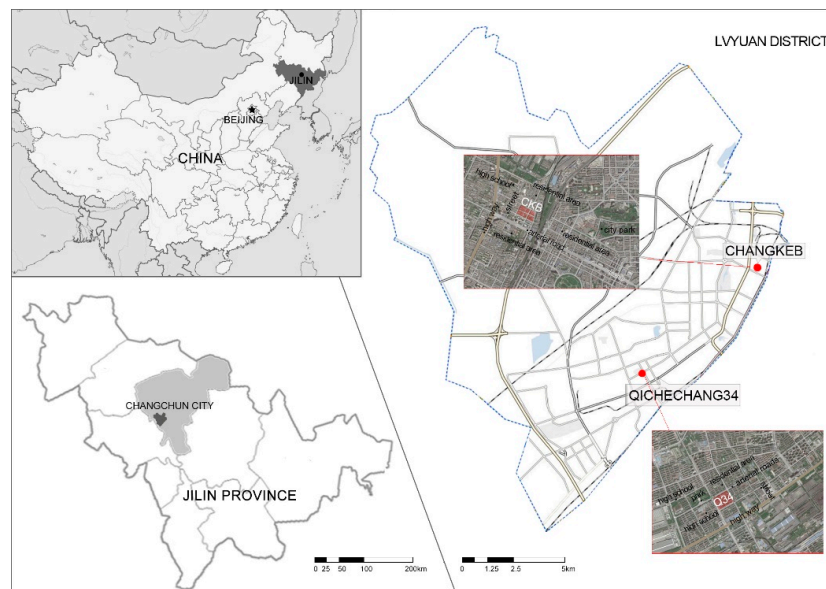

Figure 1. Location of the case studies.

Table 1. Details of samples (from the sub district offices, 2017).

Name	open housing block: CKB	gated housing block: Q34
Location	Lvyuan District	Lvyuan District
Area	60,952 m^2	83,430 m^2
Age	completed in 1988	completed in 1985
Story	6~7	6~7
Building Amount	21	22
Household	1140	1300
Population	3100	3541
The Aged	28.4%	29.7%
Residents	employees of Changke factory	employees of the Yiqi factory

2.2. Investigation of Activities in Outdoor Spaces by the Place-Centered Behavior Mapping Method

The investigation was conducted during 4–10 September; two weekdays and two weekend days were chosen to avoid dramatic phenomenon. The routes that consists of six sections and passes through the entire residential area were set in two housing blocks, respectively (Figure 2). The author walked on the predesigned routes, and recorded outdoor activities on the base map by place-centered behavior mapping method [25,26]. Staying for about 15 min on each section of the route, and making sure the accuracy of information recording, the whole route took around 1.5 h. A 12-h day, from 7:00 a.m. to 7:00 p.m., was divided it into six periods, such that each period could meet the time requirement to finish the whole route. Information was recorded in all six periods per day.
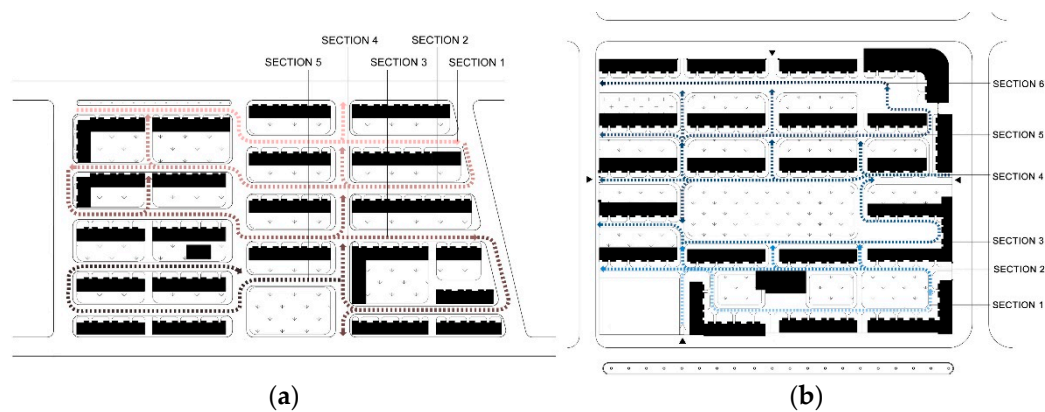
(**a**)　　　　　　　　　　　　　　　　　　　　　　(**b**)

Figure 2. Behavior mapping route: in CKB (**a**); and in Q34 (**b**).

2.3. Data Processing

Averaged the amount of behaviors of four days, 1004 behavior points were found in two housing blocks, behaviors of six time periods were recorded and overlapped to be a whole one (Figure 3).

The behavior maps of resident activities of CKB and Q34 are roughly divided into 43 and 41 sections, respectively, according to space locations (Figure 4). The elements of these areas were extracted and classified by factor analysis and cluster analysis for learning the relation of space types and environmental behaviors. A area refers to the boundary space, where housing blocks has relationship with the public space. In the open housing block CKB, these boundary spaces are totally open to the public, and is defined as Ao area; for the gated housing block Q34, residential areas have relationship with public spaces through gates, and is defined as Ag type. B area means the intersection space of housing blocks, while internal roads in CKB have been reconstructed to urban roads, this kind of spaces is defined as Bo type; and the similar space in Q34 is Bg type. C area, the unit front road space, is also divided into Co and Cg type in CKB and Q34 due to the difference of road functions. The typical space of each housing blocks can be seen in Figure 5.
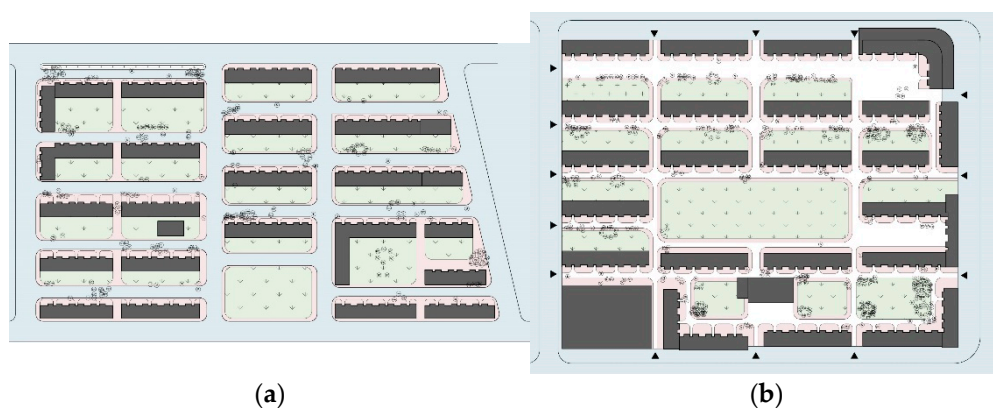

(**a**)　　　　　　　　　　　　　　　　　　　　　　(**b**)

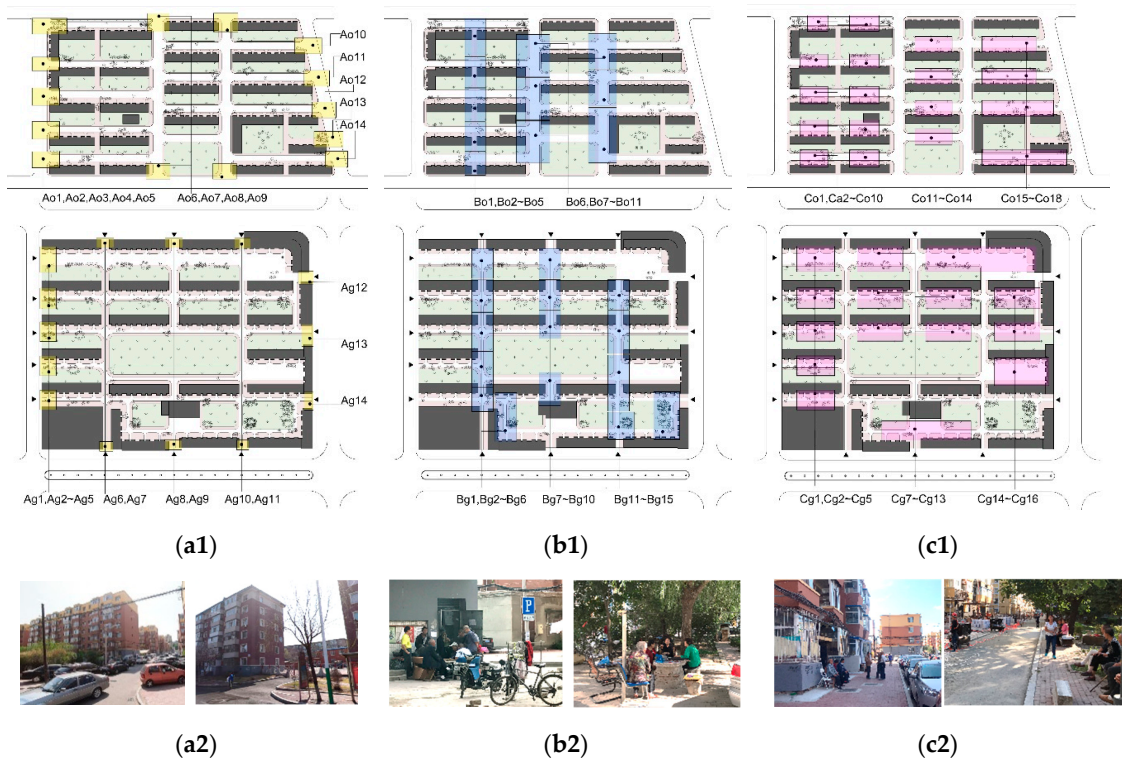**Figure 3.** Environmental behaviors: in CKB (**a**); and in Q34 (**b**).

(**a1**)	(**b1**)	(**c1**)

(**a2**)	(**b2**)	(**c2**)

Figure 4. (**a1**,**a2**) A area-boundary spaces; (**b1**,**b2**) B area-intersection space; and (**c1**,**c2**) C area-unit front road space.
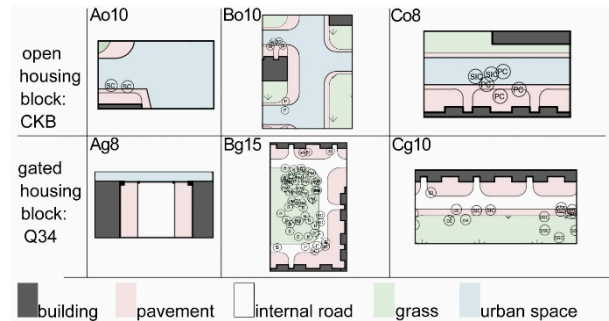

Figure 5. Typical areas in CKB and Q34.

3. Results

3.1. Characteristics of Residents' Behaviors

　　Behaviors were divided into two main categories based on their movement (Table 2): (staying activities) and (non-staying activities). The duration of non-staying activities is very short; people are usually just passing by when they do these activities. Comparing with staying activities, these behaviors are relatively less dependent on the environment and the space. Since we wanted to understand the relationship and its differences between spaces and behaviors, we focused on staying activities, which stay in a certain space longer and are more related to the space. Four kinds of activities are extracted from staying activities: (1. standing activities); (2. sitting activities); (3. certain group activities); and (4. others).

Table 2. Behavior frequencies in two housing blocks.

Behavior Frequency in CKB				
Non-Staying Activities		Cycling	37	
		Passing by	94	141
		Walking dog	10	
		Walking baby	33	78
		Walking together	45	
Staying Activities	Standing activities	Standing	17	
		Standing and chatting	25	46
		Standing with cellphone	1	
		Standing with wheelchair	3	
	Sitting activities	Sitting	18	
		Sitting and chatting	77	
		Sitting with tea table	1	101
		Sitting with newspaper	2	
		Sitting together with pets	3	
	certain group activities	Playing cards	22	
		Playing chess	18	46
		BBQ	6	
	Other activities	Kids playing	8	
		Sweeping around	1	13
		Washing car	2	
		Airing clothes	2	
Behavior Frequency in Q34				
Non-Staying Activities		Cycling	14	
		Passing by	103	127
		Walking dog	10	
		Walking baby	34	34
Staying Activities	Standing activities	Standing	18	73
		Standing and chatting	55	
	Sitting activities	Sitting	19	
		Sitting with cellphone	1	169
		Sitting with pets	1	
		Sitting and chatting	148	
	certain group activities	Playing cards	16	
		Playing mahjong	60	110
		BBQ	34	
	Other activities	Kids playing	18	
		Doing exercise	3	
		Airing clothes	2	32
		Washing car	1	
		Smoking	5	
		Sleeping on the bench	3	

In the open housing block CKB, resident behaviors were recorded 425 times, consisting of 219 non-staying activities and 206 staying activities, which is quite equal. Among the staying activities which is more related to physical environment, sitting activities rank first with 101 times; standing activities come next with 46 times, the same as certain group activities; and other activities were last with 13 times. Gated housing block Q34 showed different situation from CKB. Staying activities account were recorded 384 time, more than twice as many as non-staying activities (161). Sitting activities also ranked first in this gated housing block, with 169 times; certain group activities followed with 110 times; and standing activities and other activities came as third and fourth, with 73 times and 32 times, respectively. Although the two ranks are in a similar order, the frequency of human behaviors in the gated housing block are much higher than in the open housing block. Nevertheless,'sitting activities were popular in both housing blocks. In addition, gated housing block Q34 had obvious "certain group activities", which is not so obvious in the open housing block.

3.2. Spatial Types Analysis According to Classification of Elements in Outdoor Spaces

3.2.1. Classification of Space Elements

Data related to the elements of a space, such as boundary, interfaces, and relation to buildings and roads were collected and tabulated. These elements were classified according to their existence or non-existence in each section (Table 3) as 1 and 0, respectively. The spatial elements in CKB and Q34 were analyzed using Factor Analysis method. The result shows that the cumulative contribution rate is over 80% and 70%, respectively. Data can be seen in Columns 1–3 of Table 4.

In Table 4, there were negative eigenvalues in Column 1 for features (facing the unit building) and (near the unit entrances), while positive eigenvalues for features (facing the side of the unit building) and (having more than two roads crossed). Therefore, Column 1 compares spaces near unit buildings. The negative eigenvalues in Column 2 indicate constituting elements of closure by (having 2 or more enclosure interfaces), while the positive eigenvalue indicates openness by (adjacent to urban space). Therefore, Column 2 indicates the openness and closure of spaces. The maximum eigenvalue of Column 3 indicates features (having partition between residential and urban space), which is similar to Column 2. Therefore, Column 3 indicates the boundary and closure of spaces.

Only two columns were extracted by factor analysis in gated housing block Q34. The negative eigenvalues in Column 1 indicated features (facing the unit building) and (near the unit entrances), while the positive eigenvalues indicated features (facing the side of unit building). Therefore, Column 1 compares spaces near unit buildings, which is similar to the phenomenon in CKB. The negative eigenvalue in Column 2 indicates constituting elements of closure by (having 2 or more enclosure interfaces), and the positive eigenvalue indicates openness by (having more than two roads crossed). Therefore, Column 2 indicates the openness and closure of spaces from another way.

3.2.2. Classification of Space Types

Spatial types in two housing blocks were summarized by clustering analysis which is widely used in Typological analysis (Figure 6) [27]. Four types were extracted in open housing block CKB defined as To (Type of open). Three types were picked in gated housing block Q34 named as Tg (Type of gated).

In CKB, To1 consists of seventeen Co areas, referring to the area located on unit front roads in open housing block. There are some subtle differences inside, such as Co17 and Co18, which have a cross road. To2 is a special space type because it only made up a single area of Co14. Although it has a similar location with other Co areas in Type 1, Co14 is different from others in the enclosure. It is close to urban space. There is no partition or unit building between it and outside, therefore, visually and spatially, the privacy of Co14 is lower than other Co areas. To3 is formed by all Ao areas, which represents the boundary space in CKB. In this type, Ao7 looks difference with other Ao areas on the interface. It is located between the side face of two unit building, and it has two solid interfaces accordingly, which is different from other boundary spaces with one only. Areas of To4 all belong to Bo, which are intersection spaces. Bo1 and Bo5 see one difference of location. They are closer to urban space than remaining Bo areas. As can be seen, To2 is the most special type in the open housing block CKB. Before CKB was transformed into an open block, one side of this type is the apartment building, and the other side is the enclosure of the urban space. The demolition of the space elements is similar to other Co areas while dismantling boundary walls made this area separate from other Co areas and became a new type of space, To2. Meanwhile, in the other three types, there are also differences within space types accordingly because of the different spatial elements in each region.

Table 3. Existence and Non-existence of spatial elements in two housing blocks.

Element / Area	Ao1	Ao2	Ao3	Ao14	Bo1	Bo2	Bo3	Bo11	Co1	Co2	Co3	Co18	Ag1	Ag2	Ag3	Ag14	Bg1	Bg2	Bg3	Bg15	Cg1	Cg2	Cg3	Cg16
adjacent to urban space	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
partition b/w residential & urban space	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0
having more than two roads crossed	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	0	1	1	1	1	0	0	0	0
the width of road is more than 6 meters	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
facing the unit building	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1
facing the side of unit building	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0
having 2 or more enclosure interfaces	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
having plants	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
near the unit entrance	1	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1

Table 4. Rotated Component Matrix of two housing blocks.

	CKB			Q34	
Elements	1	2	3	Axis1	Axis2
adjacent to urban space	0.350	0.855	0.174	0.658	0.709
having partition between residential and urban space	0.155	0.037	0.919	0.658	0.709
having more than two roads crossed	0.847	0.285	0.024	0.194	−0.876
the width of road is more than 6 m	0.340	0.477	−0.527	0.168	−0.562
facing the unit building	−0.885	−0.392	0.018	−0.924	0.028
facing the side of unit building	0.876	0.393	0.022	0.950	−0.147
having 2 or more enclosure interfaces	−0.227	−0.838	0.192	0.037	0.481
having plants	−0.047	−0.753	0.046	−0.611	−0.427
near the unit entrances	−0.915	0.100	−0.030	−0.841	0.307
Cumulative contribution rate	38.01%	29.22%	13.26%	41.88%	29.09%
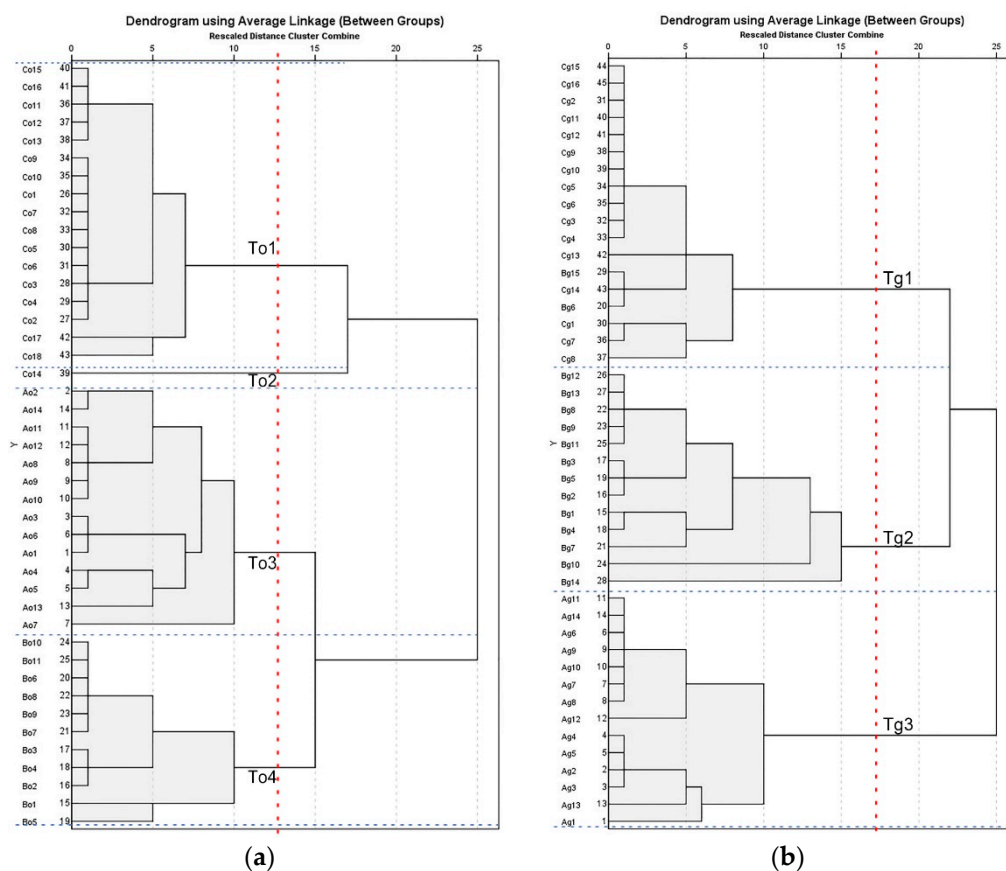
Figure 6. Cluster of areas in: open housing block CKB (**a**); and gated housing block Q34 (**b**).

In gated housing block Q34, areas are classified into three types only. There are 18 areas belonging to Tg1 (Tg: Type of gated), most of which are located in the Cg area of unit front roads, but Bg6 and Bg15 at the road intersection also belong to this spatial type. There are different spatial interfaces between Bg6 and Bg15 and other intersection areas. These two regions have three solid enclosure surfaces. Compared with other Bg spaces, they have weaker openness. The composition of Tg2 is relatively clear, which is the rest of all Bg regions, and there is no significant difference between this type of region. Tg3 includes all Ag areas, which are boundary spaces. Obviously, the internal difference exists in T3. Ag1, Ag2, Ag3, Ag4, Ag5, and Ag13 are different from other space, as these six boundary spaces are located on the two sides of the residential area and close to the entrance of the cell building. This means that people are more likely to appear in such spaces, while the other Ag spaces are far away from the cell exit.

3.3. The Distribution of Behaviors in Space Types

To understand the reflection of behavior on the type of spaces, we compare the distribution of four activity categories in each space type.

In open housing block CKB, 22 areas were recorded to have [standing activities]. As the average frequency in these 22 regions is about 5%, the number of occurrences over 5% is defined as "high frequency". In Figure 7, three areas in Type 4 are higher than 5% (Bo6, Bo8 and Bo4), while there are only one or two areas of other types. Twenty-four regions were found to have [sitting activities], and the "high frequency" is also set as 5% similar to the last behavior type. Three regions in Type 3, Ao1, Ao6 and Ao13, exceed this standard. For the [certain group activities], it is noticed in nine areas, thus the frequency standard is defined at around 10% accordingly. Type 1 has several areas whose frequency is higher, especially for Co3 area (17%). For the [other activities], eight regions of this category have other activities. Using the general standards of 10%, Co15, Co10 and Co13 in Type 1 were picked as noticeable areas. As above, each type of space attracts specific activities, particularly for Type 1, which is the high-frequency area of [certain group activities] and [other activities], but the overall distribution is relatively even.
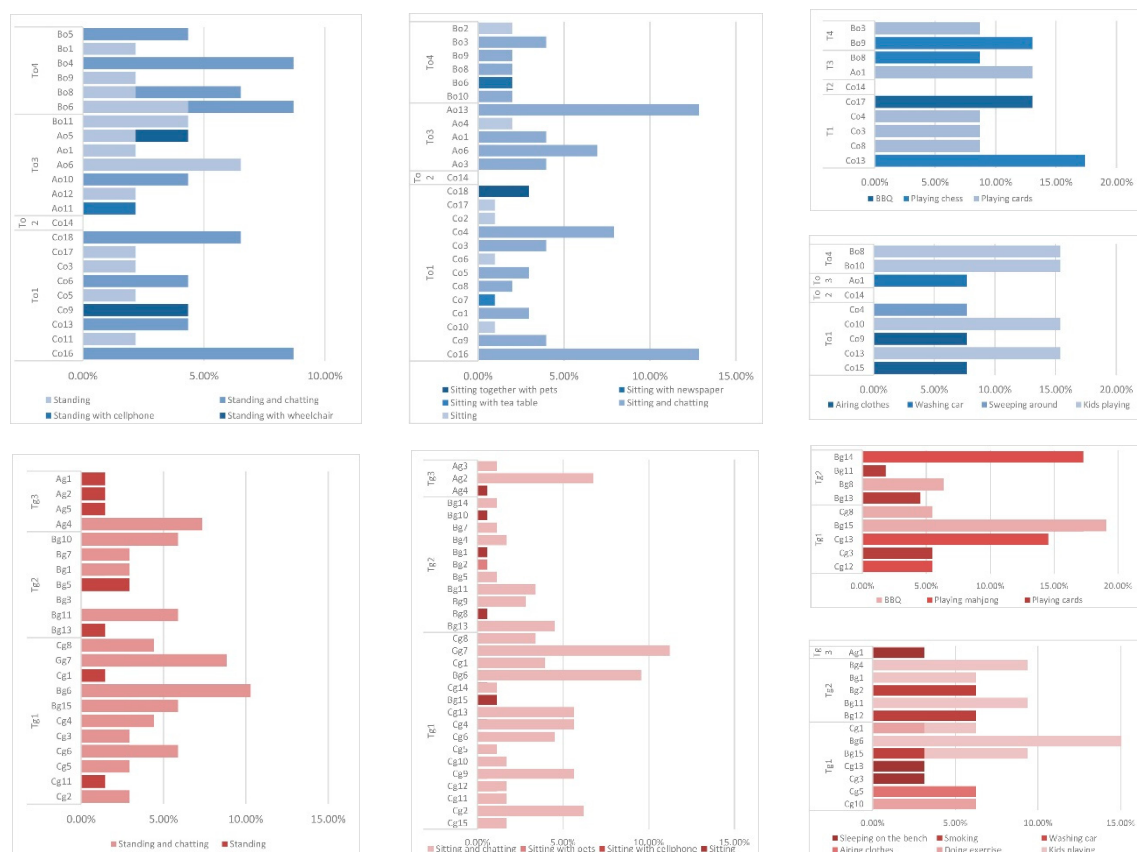

Figure 7. Distribution of four activity categories in each space type in open housing block CKB (To1, To2, To3 and To4) and gated housing block Q34 (Tg1, Tg2 and Tg3).

In gated housing block Q34, 21 regions are recorded for the [standing activities]. Since the value of high frequency is set to be higher than the average probability of 5%, four regions in Type 1, Cg6, Bg15, Bg6 and Cg7, looks higher than this figure, especially Bg6, which is about 14%. For [sitting activities], as it is noticed in 30 areas, the frequency standard is defined at around 4%. Type 1 sees higher frequency in eight areas, especially for Cg7 area (10%). Nine regions were found to have [certain group activities], and the "high frequency" is also set around 10%. Two regions in Type 1,

Cg13 and Bg15, exceed this standard. Bg15 has a relatively high value of 37%. Thirteen regions of this category have [other activities]. Using the general standards of 8%, Bg15 and Bg6 in Type 1 were picked up to be noticeable areas, and the behavior frequency in Bg6 ranks first, which is higher than 15%. Different from the situation in CKB, remarkably, four categories of behaviors all show highest frequency of occurrence in Type 1.

4. Discussion

The impact of demolishing wall and changing internal roads on the environmental behaviors have not been demonstrated in previous studies yet, while many scholars have explored the impact on environmental behavior with these physical characteristics [28–32]. The importance of bounded walls and internal roads are also confirmed in some series of studies. In the case of open housing block in this paper, the removal of walls and the change of internal roads did affect the division of space types, the attraction of various space types to residents, and the characteristics of the residents' activities. By contrast with gated housing blocks, these effects are presented more clearly.

However, this article has some limitations in the comparative study. It is more accurate to discuss the influence of the transformation by comparing the statuses before and after reconstruction of the same housing block, while, due to the implementation of the policy, the settlement is often in the state of being transformed when it is publicized, and it is difficult to find it in advance and commit research. In addition, some studies have chosen longitudinal comparisons, such as drawing historical maps through interviews and then comparing them with current situation [33]. This kind of comparative study is reliable in presenting the physical features, yet it is not applicable to the study of environmental behaviors because the memory of activities is often vague and easy to change with the passage of time and changes of residential status. In this study, the crosswise comparison was finally adopted, and a fairly comparable control group was paired for the experimental open case, which is similar in area, layout, surroundings, and population. Therefore, the accuracy of this comparative research could be guaranteed to a certain extent.

5. Conclusions

This research compares open and gated housing blocks, the CKB and the Q34, from aspects of resident behaviors, space types and the distribution of residential behaviors in each space type. From these three aspects, a series of conclusions are drawn.

(1) In the staying activities, which is more related to the space, [sitting and chatting] has the highest frequency in both open housing block CKB and gated housing block Q34, but the number in Q34 is more than twice as in CKB. As the CKB have in common with the Q34 population and area, this phenomenon is presumed to be associated with a significant difference of two housing blocks, open–closed state.

(2) After the factor analysis of space elements in two housing blocks, it is known that influencing factors in open housing block are "near unit buildings", "openness and closure of spaces" and "boundary and closure of spaces", while influencing factors in gated housing block are "near unit buildings" and "openness and closure" only. Therefore, the spatial classification will be more explicit and steady in the latter. In the subsequent cluster analysis, the CKB and the Q34 were divided into four and three main spatial types, respectively. In particular, Co14, To2 of CKB was distinguished from other Co areas to be an independent type because dismantling boundary walls changed the elements of this region.

(3) By analyzing the distribution of residents' behavior in space types, we can see that, in CKB, the frequently occurring locations of the four main activities are scattered in the various types of To1, T3, and To4. In these types, Ao13, Bo6, and especially Co13 appear many times. These areas are located at the boundary of the residential area, the road node of the residential area and the position of the unit front road of the residential center. However, there is a more dramatic situation in Q34;

all high frequency locations of activities belong to Tg1, of which Cg7, Cg15, and especially Bg6 should be paid attention. These areas are located in the front road of unit buildings, and two of them have three solid interfaces, with a strong sense of space and privacy.

The presence or absence of the enclosing walls affects the distinction of space types in housing blocks. In the case of gated housing blocks, closed space and strong private space attract various types of activities, which are rich in category and number of people. In the case of open housing blocks, closed space and strong private space still attract most kinds of activities, but the other two types of space located at the intersection road and the boundary also attract other activities.

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