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Residents' Spatial-Usage Behavior and Interaction According to the Spatial Configuration of a Social Housing Complex: A Comparison between High-Rise Apartments and Perimeter Block Housing

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Abstract: It has been claimed that high-rise apartments, unlike perimeter block housing, cause social pathology; however, no studies have quantitatively proven this. Therefore, this study aimed to analyze the difference between space-use behavior and social interactions with a focus on high-rise apartments, the main residential mode in South Korea, and the newly created perimeter block housing. This was done by first comparing and analyzing the spatial configurations of high-rise apartments and perimeter block housing using the space syntax methodology. Second, the space-use behaviors that affect interaction were explained by regression analysis after analyzing correlations among the spatial configurations of individual residence locations, the frequency of use of community facilities, and interaction. Third, differences in interaction for people living in complexes with different spatial configurations were analyzed using *t*-tests. The main finding was that people whose living arrangements include a good spatial configuration or that often use children's playgrounds interact more. Additionally, when the spatial configuration of a complex is systematic and the complex is closely connected to the city, the interaction between neighbors appears better. The results of this study demonstrate that block housing promotes interaction, which will be helpful for establishing new planning standards for sustainable apartments.

Keywords: sustainable residential architecture; social interaction; spatial configuration; space syntax

Citation: Kim, J.Y.; Kim, Y.O. Residents' Spatial-Usage Behavior and Interaction According to the Spatial Configuration of a Social Housing Complex: A Comparison between High-Rise Apartments and Perimeter Block Housing. *Sustainability* **2022**, *14*, 1138. https://doi.org/10.3390/su14031138

Academic Editors: Mi Jeong Kim, Jae Kyung Kim and Eun Joo Park

Received: 17 December 2021
Accepted: 16 January 2022
Published: 20 January 2022

1. Introduction

Korea has a high rate of high-rise apartment development as a result of its rapid economic development. Studies show that residents experience social pathology in a high-rise residential environment [1–4]. Of relevance here is that this problem has been reported in rental housing supplied to the low-income class in Korea. Research also shows a higher suicide rate among people living in high-rise rental housing than those living in poorer shantytowns [3]. Nonetheless, in Korea, following many stages of branding and upgrading over a long period, the high-rise apartment has become the favored residential form. Countries in Europe, and the United States of America—developed countries that have experienced housing growth—have experienced problems associated with high-rise apartments and, as a consequence, high-density, mid- to low-rise block housing has been adopted [5,6]. Newman's study shows that the spatial composition of private and public spaces, such as the layout of mid- to low-rise block housing, is strongly related to residential safety [7].

Currently, to create a healthy residential environment, ahead of the third New Town development, with its goal of producing a mass housing supply, the overall trend is for new dwellings to be built as mid- to low-rise perimeter block housing, rather than high-rise apartments. However, there has been no comparative analysis of social interaction in high-rise apartments and perimeter block housing. Therefore, the social–spatial characteristics of these two forms of housing require objective and empirical research. In this regard, spatial configuration is considered an important factor in interactions between people and creating a healthy residential environment [8,9]. Thus, the purpose of this study was to compare the frequency of interaction between neighbors, based on the type of spatial configuration: high-rise apartments and the perimeter block housing.

This study focused on high-rise apartments and perimeter block housing complexes in a district in a metropolitan area in Korea. In particular, the analysis targeted public rental housing. According to Lee's study (2012), people who live in areas in which low-income families are concentrated are affected by their physical residential environment [10].

The analysis proceeded as follows. First, it investigated the physical environment and residential characteristics of the study site. Second, it constructed a spatial-configuration model using the space syntax methodology, and it analyzed the spatial hierarchy for each area via quantitative analysis. Third, it analyzed the space-use behavior and frequency of interaction between neighbors in the target area using basic data from a survey by the Korea Land and Housing Corporation. Finally, it statistically demonstrated differences in the frequency of interaction according to the form of spatial configuration.

2. Literature Review

2.1. The Residential Environment of the High-Rise Apartments and Perimeter Block Housing

As of 2020, apartments accounted for 51.5% of the housing types in Korea: thus, more than half of Koreans live in apartments [11]. This means that apartments in Korea are considered an important residential environment. The typical housing type in Korea is a plate-type/tower-type high-rise apartment with 20 stories or more. The problem of high-rise apartments in Korea began in the late 1990s, and the necessity for perimeter block housing as a mid- to low-rise housing complex has since been discussed [12].

It was not until 2007 that the construction of perimeter block housing was attempted in Korea. Jacobs argued that small block sizes in an urban context increase social interaction among urban residents [13]. In developed countries, large and high-rise apartment complexes have been changed and settled into a low-rise/high-density residential environment. Newman [7] shows that high-rise housing is not defended against crime: by comparing high-rise and to mid- to low-rise houses, it was demonstrated that as the number of floors in a building increases so too does the crime rate. Moreover, a study by Gifford [1] shows that the residential environment of high-rise apartments not only increases the crime rate but leads to mental problems and family discord and affects altruistic behavior and relationships between neighbors. In the Lester [4] and Panczak et al. [14] studies, suicide—the most extreme situation of social pathology—occurs at a high rate among high-rise residents. Kim et al. [3] also showed that Korea has a high suicide rate in its high-rise residential areas. This is because as semi-private space decreases, building management is neglected. As a result, it is argued that surveillance is difficult, and an unsafe environment is created [7]. In addition, an isolated space appears as a private space, which results in spatial and social isolation for residents and less interaction with neighbors [15,16].

Research on perimeter block housing is mainly conducted in relation to arranged interactions. In his book *Soft City*, David Sim [17] discusses planning factors including perimeter block housing arrangements and recommends the inclusion of features such as enclosed spaces and smaller courtyards. This gives an identity to each block and shows that interaction between people occurs via a stepwise spatial hierarchy of space from private space, through shared private space, to common space. In several studies, the type of perimeter block housing is referred to as a courtyard or patio, for example. Sano et al. showed that courtyards facilitate public–private interaction, using low-rise, high-density housing in Tokyo, Japan as an example [15]. Kong et al. demonstrated the appearance of a stepwise spatial hierarchy of space and verified that spatial intelligibility is high by analyzing European perimeter block housing [18]. Many studies also compare the interaction behavior and social culture associated with a space by understanding that the courtyard residential environment in any country is where interaction occurs [19–21].

However, in terms of the interactional environment, research on the residential environment of high-rise apartments and perimeter block housing is dealt with separately. That is, no study compares the residential environment of high-rise apartments—where interactional problems occur—and perimeter block housing, which facilitates interaction.

2.2. The Relationship between Spatial Configuration and Interaction in a Residential Environment

Spatial configuration is shown to be an important factor in determining people's interaction behavior [22–24]. One approach to measuring spatial configuration quantitatively uses space syntax theory. With this methodology, studies analyzing the residential environment incorporate crime, interaction, walking, and function as spatial-configuration characteristics. For example, Friedrich et al. [25] and Matijosaitiene [26] explain the characteristics of crime-prone areas in terms of spatial configuration. Kim et al. [2] describes that spatial configurations of living units are related to suicide rates. Kim and Kim [8] show that spatial configurations of living units housing the elderly are related to their social networks.

Many other studies describe interaction and vibrant spaces by analyzing the inner and outer spaces of houses or urban streets connected to housing complexes [27–29]. A common feature of those studies is that places with high accessibility in their spatial configuration are potential spaces where interaction between people occurs frequently. Suicide rates are also higher among people living in secluded spaces isolated from the surrounding area [2]. However, depending on the situation, people's behavior may be counter to this. In complexes where residents have been settled for a long time, people show a high tendency to interact with others when accessibility to their residences is low. As interaction in such spaces is not straightforward, because of spatial characteristics, the desire to meet people increases [8]. Although secluded areas are regarded as unsafe space because of a lack of surveillance, crimes such as theft require an escape route and so are more likely to occur in places that are well connected to the city than in an isolated area [26]. Thus, unlike for open urban, commercial, and work spaces, when describing a residential environment, it is important to take into account the private and public behavior of the residents.

2.3. The Residential Environment and Interaction among Low-Income Families

The government of Korea has supplied a large amount of public rental housing as a part of its policy of "stabilizing housing welfare for low-income families." However, this public rental housing is planned without consideration of the characteristics of residents and communities [30]. Since housing supplied to date is in the form of large apartment complexes, residents suffer from hindered social interaction [31]. One survey shows that community facilities have low accessibility and have been neglected as they are located in the corner of the complex [32]. In addition, large complexes are physically disconnected from their surroundings, which worsens "social exclusion" [33,34].

Given physical planning issues, rental housing in which low-income families are concentrated lacks support for facility management and provision of a sense of community for residents. Thus, insufficient community facilities are provided [35]. In addition, it appears that there are restrictions on improving interaction or communication between neighbors because low-income residents may be less active or their lives difficult [36–38]. However, they interact positively for the purpose of exchanging information related to disability and livelihood [38].

Based on the premise that low-income families are affected by physical environmental change, in a study by Lim et al. [39], improvements in the housing environment were attempted to enhance interaction within low-income residential areas. This shows that physical changes in practice improve social relationships. The physical change involved installation and maintenance of community facilities, and the findings confirm the importance of community facilities. In addition, in studies measuring interaction among low-income residents, surveys show that the use of community facilities are related to the physical environment. Similar to the study of Lim et al., Lee and Kang [40] show that interactions between neighbors occur in corridors, playgrounds, private houses, and the building's main entrance. The playground appears to be an important place among community facilities. A study by Park and Kang [41] shows that residents using a walking trail more have a higher sense of community participation in a public rental housing complex. The accessibility of community facilities appears to be another important factor. Additionally, in a study by Choi and Kim [42], as the frequency of use of community facilities by residents increases, the frequency of interaction among neighbors increases, and stress decreases.

Taken together, these studies show that low-income residents have fundamental limitations in terms of interaction but have the potential to improve their interactions if the physical living environment is improved. The physical environment appears to be particularly related to the use of community facilities. Therefore, the current study focused on the importance of a residential environment that promotes interaction between low-income residents.

3. Methods

3.1. Case Study Area

A high-rise apartment complex and a perimeter block housing complex were chosen as target areas for this study. The high-rise apartment complex is the most-common dwelling type, while perimeter block housing complexes are a new type of dwelling in Korea. To control for the economic and cultural characteristics of residents, National Rental Housing [43] (Korean social housing programs include Permanent Rental Housing, 50-year Rental Housing, National Rental Housing, and Shift Housing. National Rental Housing is the most-important housing program for low-income families. Depending on the size of the rental housing, 10–40% of the construction costs are now met by the national government budget.), among social housing types of the same type and in the same district, was chosen.

The selected high-rise apartment complex (hereinafter referred to as "Site A") has a land area of 47,937 m^2 with 13 residential buildings that are 20 stories high with 1450 households and a 13.72% building-coverage ratio. The form of the residential building involves a mixture of plate and tower types. The selected perimeter block housing complex (hereinafter referred to as "Site B") has a land area of 33,560.4 m^2 with six residential buildings that are 6–15 stories high with 858 households and a 41.33% building-coverage ratio. These two complexes thus differ in the number of stories, and the building-coverage ratio, based on the form and arrangement of the residential buildings.

In terms of locational characteristics, as Figure 1 shows, Site A is surrounded by parkland to the west and south, another large apartment complex to the east, and a low-rise housing complex to the north. Within a 500 m radius of the target site, there are schools, public facilities, and a mixed non-residential-use industrial area. There is fair accessibility to Site A via two roads intersecting in the north-east. Site B has a river to the south and a welfare center to the west. It is also surrounded by apartment complexes to the east and north. Site B has better accessibility to residential complexes than does Site A, and commercial facilities are also located nearby. The access roads to the complex are closely connected to surrounding areas to the east, north, and south.

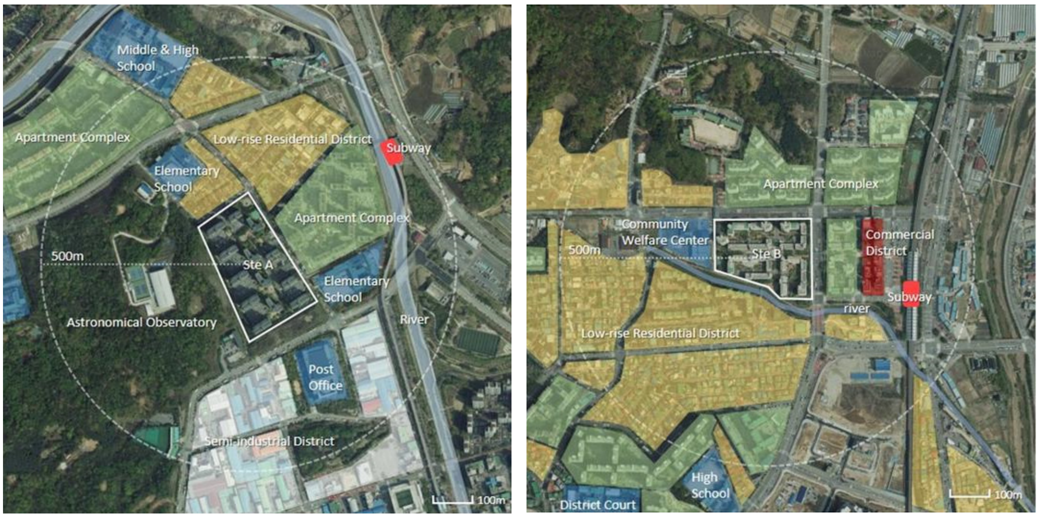
Programs according to function of the complex are shown in Table 1 and facility arrangements are shown in Figure 2.

Table 1. Characteristics of the arrangement of community facilities.

	Site A		Site B	
	N	**Location and Shape**	**N**	**Location and Shape**
Residential buildings	13	A separate building	6	The building is connected to each other by a bridge
Commercial facilities	1	A separate building	3	Located on the first floor in residential buildings
Senior-citizen centers	-	-	1	Located on the first floor in residential buildings
Management offices	6	In a separate building	5	Located on the first floor in residential buildings

Table 1. *Cont.*

	Site A		Site B	
	N	**Location and Shape**	**N**	**Location and Shape**
Libraries	-	-	1	Located on the first floor in residential buildings
Nursery schools	1	In a separate building Using a private playground	1	Located on the first floor in residential buildings Using a public playground
Sports facilities	2	Outdoors	1	Two outdoors, one indoors
Children's playgrounds	6	Located in the center of the complex	2	Located on the first floor in residential buildings



(**a**) (**b**)

Figure 1. The location characteristics of (**a**) Site A and (**b**) Site B.

Figure 2. The arrangement of community facilities.

3.2. Materials and Design

This study examined the difference in interaction between residents according to spatial configuration and the pattern of usage of community facilities according to the arrangement of the complex. Fundamental data employed in the analysis are the spatial configuration, the pattern of usage of community facilities, and the interaction between residents. For spatial configuration, living spaces able to influence interaction between residents were analyzed. For the pattern of usage of community facilities, the frequency of use of facilities that promote interaction was analyzed. Additionally, the number of acquaintances who greet one another was used as a measure of the frequency of interaction. The results of a survey conducted by the Korea Land and Housing Corporation (2020) were used as data on the pattern of usage of community facilities and interaction between residents. This information is described in more detail in Section 3.4.

Statistical analysis was conducted at two levels: personal and collective. First, at the personal level, the effect of characteristics of individual space-use characteristics on the frequency of interaction was analyzed. The configuration is represented by accessibility of the personal residence location, and the pattern of usage of community facilities was measured as the frequency of use of each facility. A spatial-configuration indicator of the residence location and community facilities that are related to the interaction was determined. A multiple-regression analysis was conducted by using the extracted indicator as the independent variable, with interaction as the dependent variable. Through this process, the spatial characteristics that affect individual interactions were analyzed.

Second, at the collective level, differences in the frequency of interaction were analyzed for the different spatial types represented by Site A and Site B. The spatial configuration at the collective level was the spatial characteristic of each complex. The spatial configuration of each complex was analyzed by comparing the arrangement characteristics of the facility. The average frequency of interaction for each complex was analyzed and the significance of the difference determined by an independent-sample *t*-test. Through this process, the spatial characteristic of the complex that promotes interaction was analyzed.

3.3. Methodology Applied: Space Syntax

Space syntax theory was used in the analysis of the physical residential environment. It provides an effective quantitative indicator of the spatial configuration. Thus, to understand people's space-use behavior, the spatial configuration to which the space syntax theory is applied was analyzed in this study. The spatial range is the entire district including the target area in each case, including the roads inside the complex and the main entrance. Because of the characteristics of Korean cities, the target areas in the study consist of multi-level spaces such as rivers, underground roads, and three-dimensional pedestrian passages. Among space-syntax-analysis methods, an axial line analysis capable of analyzing urban and multi-layered spaces was applied. The Qgis open-source online map was used as the basic data for structuring axial line modeling. The Depthmap, which is one type of plug-in in Qgis, was used to analyze spatial configuration. Global integration, local integration, and intelligibility were measured to facilitate data analysis.

Global integration, in terms of the urban aspect, refers to the accessibility and hierarchical characteristics of each space. Local integration involves accessibility to surrounding areas. Intelligibility was used to analyze the degree of spatial hierarchy. Thus, the higher the global integration value for a particular space, the easier it is to access that space from the city. Such as space is said to be close to the central space of the city because of its high spatial hierarchy. In contrast, the lower the global integration value for a space, the more difficult it is to access from the city. Therefore, it is highly likely to be an isolated space. If the local integration value for a specific space is high, it is considered a major space that integrates surrounding spaces. The value of intelligibility is that it analyzes not one particular place but the relationships among the overall and local characteristics of multiple spaces. A high value for intelligibility means that spaces have a stepwise hierarchy, so they have the characteristic of being easy way-finding. Thus, the study analyzed and explained the accessibility and hierarchy of complexes, community facilities in complexes, and the residents' residence locations using each indicator.

3.4. Survey

Basic data from a research report entitled "Establishment of planning direction for public rental housing in the third new city to present future housing model" (the Korea Land and Housing Corporation, 2020) were used to analyze the frequencies of interaction between neighbors. These data were from a face-to-face survey of residents from 29 April to 19 June 2020.

This study utilized response data in relation to two questions. The first question was "How many neighbors are you acquainted with?" This short-answer question allowed respondents to answer with numbers. The second question was "How often do you visit or use the community facilities?" Community facilities exist in both Site A and Site B and include management offices, children's playgrounds, benches/pavilions, and trails. This multiple-choice question provided seven options: ① never use; ② once in a while; ③ once or twice a month; ④ once a week; ⑤ twice or three times a week; ⑥ almost every day; and ⑦ unaware of the facilities.

The collected data were from 225 responses: 115 from Site A and 11 from Site B. The effective sample size was 202 after excluding the missing: 97 (6.7%) from Site A and 105 (12.2%) from Site B. The demographic characteristics in Table 2 show that the percentage of women respondents was very high, and the age groups with the highest rate of respondents were the 60s and the 70s. The most-frequent number of residents per household was two, followed by one-person households. The longest length of residence was greater than 16 years at Site A and 11–15 years at Site B. The reason for this difference in longest residence time is that people first moved into Site A in 2002 and into Site B in 2008. A length of residence of less than five years was the next-largest category.

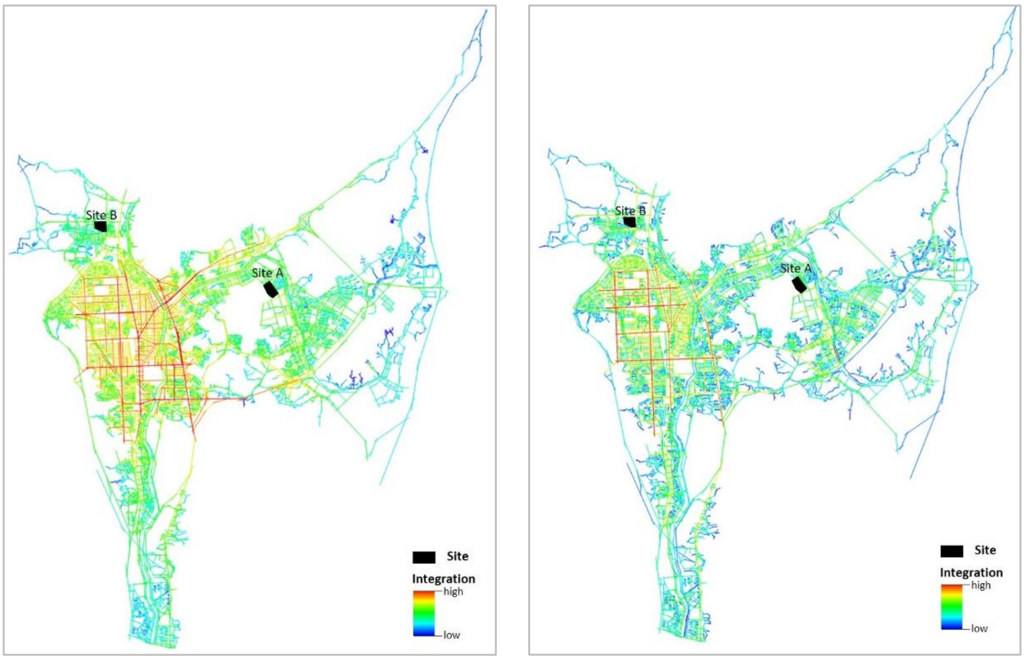
Table 2. Demographic characteristics of survey respondents.

Variables		Site A		Site B	
		Respondents (N)	**%**	**Respondents (N)**	**%**
Gender	Male	27	27.8%	37	35.2%
	Female	70	72.2%	68	64.8%
Age	10s	1	1.0%	3	2.9%
	20s	0	0.0%	9	8.6%
	30s	2	2.1%	6	5.7%
	40s	4	4.1%	16	15.2%
	50s	18	18.6%	9	8.6%
	60s	31	32.0%	29	27.6%
	70s	26	26.8%	22	21.0%
	Over 80s	15	15.5%	11	10.5%
Number of residents (per household)	1	21	21.6%	33	31.4%
	2	54	55.7%	37	35.2%
	3	13	13.4%	16	15.2%
	4	7	7.2%	16	15.2%
	≥5	2	2.1%	3	2.9%
Number of years of residence	≤5	19	19.6%	38	36.2%
	6–10	14	14.4%	24	22.9%
	11–15	11	11.3%	43	41.0%
	≥16	53	54.6%	0	0.0%
Total		97	100%	105	100%

4. Results

4.1. Spatial-Configuration Analysis

Figure 3 presents the results of the analysis of the global-integration and local-integration indices in cities including the target area. The results were visualized using spectral colors from red to purple. As shown for the global-integration analysis, the west side of the city had a high value, and the city center was skewed to the west. With the city as the center, separated areas appeared on the south and east sides. According to the location of the study area, Site A is in the separate area to the east side, and Site B is on the north side of the city center and closer to the city center than is Site A. The measured figures show that the global integration of the entire city is a minimum of 0.3401, and a maximum of 1.3959, with an average value of 0.8237. Regarding the values for the access roads at each complex, the average for Site A was 0.8978 and for Site B was 0.8904. Both sites had average accessibility from the city, but Site A was slightly more accessible than Site B.



(**a**) (**b**)

Figure 3. Urban spatial configuration and locational characteristic of the target site in terms of (**a**) global integration and (**b**) local integration.

For the results of the of local-integration analysis, a place with high accessibility from the city is shown with a red axis, and an urban grid structure was formed on the north–south and east–west axes of the city center. In addition, a village was formed on the east and north sides with yellow roads as the center. The measured figures show that local integration for the entire city was a minimum of 0.3333 and, a maximum of 4.6359, with an average of 1.5573. In regard to the values of the access roads to each complex, the average for Site A was 2.7233 and for Site B was 2.8870. The higher value for Site B than for Site A indicates that Site B has better accessibility to surrounding roads and neighboring complexes. In other words, Site A has better accessibility from an urban perspective but low accessibility in terms of communication with its surroundings. This might be due to the relationship between the surrounding roads and the internal roads of the complex. It also means that Site A is relatively isolated. In contrast, Site B has a lower quality of site location but a closer form in the internal and external spatial networks of the complex. The specific reason for this can be identified by analyzing the results of spatial configuration inside the complex.

Figure 4 presents the results from the analysis of the spatial configurations of Site A and Site B, the latter of which is connected to the city. Comparing the global integration of each complex, Site A was 0.6732 on average, and Site B was 0.7436. Site B had better internal spatial accessibility to the complex. As previously mentioned, Site A had favorable location characteristics in terms of global integration of the roads surrounding the complex. This also means that Site B, with lower locational accessibility, had better internal accessibility. The distribution of accessibility inside the complex is shown in images (a) and (b). Site A has a red axis only for the surrounding roads; toward the inside, it has an axis closer to blue. This suggests that only the surrounding area had better accessibility, but it becomes isolated nearer the inside. That is, Site A forms a complex structure isolated from the surrounding roads. At Site B, the east–west axis passing through the center of the complex is shown in red, and the part around the complex appears in blue and purple. The spatial hierarchy of the center of the complex and the courtyard appears in stages.

The values for local integration for the two complexes are 1.7860 for Site A and 1.70191 for Site B. Considering the distribution of local integration, the Site A values ranged from a minimum of 1.0208 to a maximum of 3.1772, and the Site B values ranged from 0.7278 to 2.0635. The interior of Site A showed higher accessibility to neighboring roads (the degree of the local integration was 2.7233), which indicates that accessibility to the inside of the complex was higher. In other words, it has a structure tending toward that of a gated community, as also shown in images (c) and (d). For Site A, the space facing the road is blue, while deep inside the complex (south–west axis space), the space is red. However, Site B in the drawing appears to gradually change from red to blue in the space entering the complex. That is, at Site B, the space entering the complex from outside shows a stepwise spatial hierarchy.

Graphs (e) and (f) show the results of analyzing intelligibility. Intelligibility is calculated as the correlation between global integration and local integration. When this correlation is high, the entire space can be recognized from just a part of it. High intelligibility means that the spatial hierarchy of the space is clear. The correlation values for Sites A and B were 0.1502 and 0.7367, respectively. This suggests that Site A had low intelligibility and that it is difficult to find the center of the complex; whereas, Site B had high intelligibility, so, it is expected that the spatial hierarchy such as that involving the central space and the intermediate space of the complex is clear.

Table 3 shows the results of a detailed analysis of differences in the structures of the complexes in terms of the accessibility of the space by function. For the public facilities that the two complexes have in common at the center, spaces are classified into residential buildings, entrances, parking lots, children's playgrounds, and walking trails. Considering global integration, the value for the main entrance (0.8051) was the highest, followed by children's playgrounds (0.6870), walking trails (0.6790), parking/roadways (0.6678), and residential buildings (0.6122). For local integration, the value for the main entrance (2.3918) was the highest, followed by children's playgrounds (1.9025), parking/roadways (1.9025), walking trails (1.6724), and residential buildings (1.5584). When entering this complex via the entrance, it appeared easy to first recognize the children's playgrounds and enter the residential buildings through the walking trails and road ways.

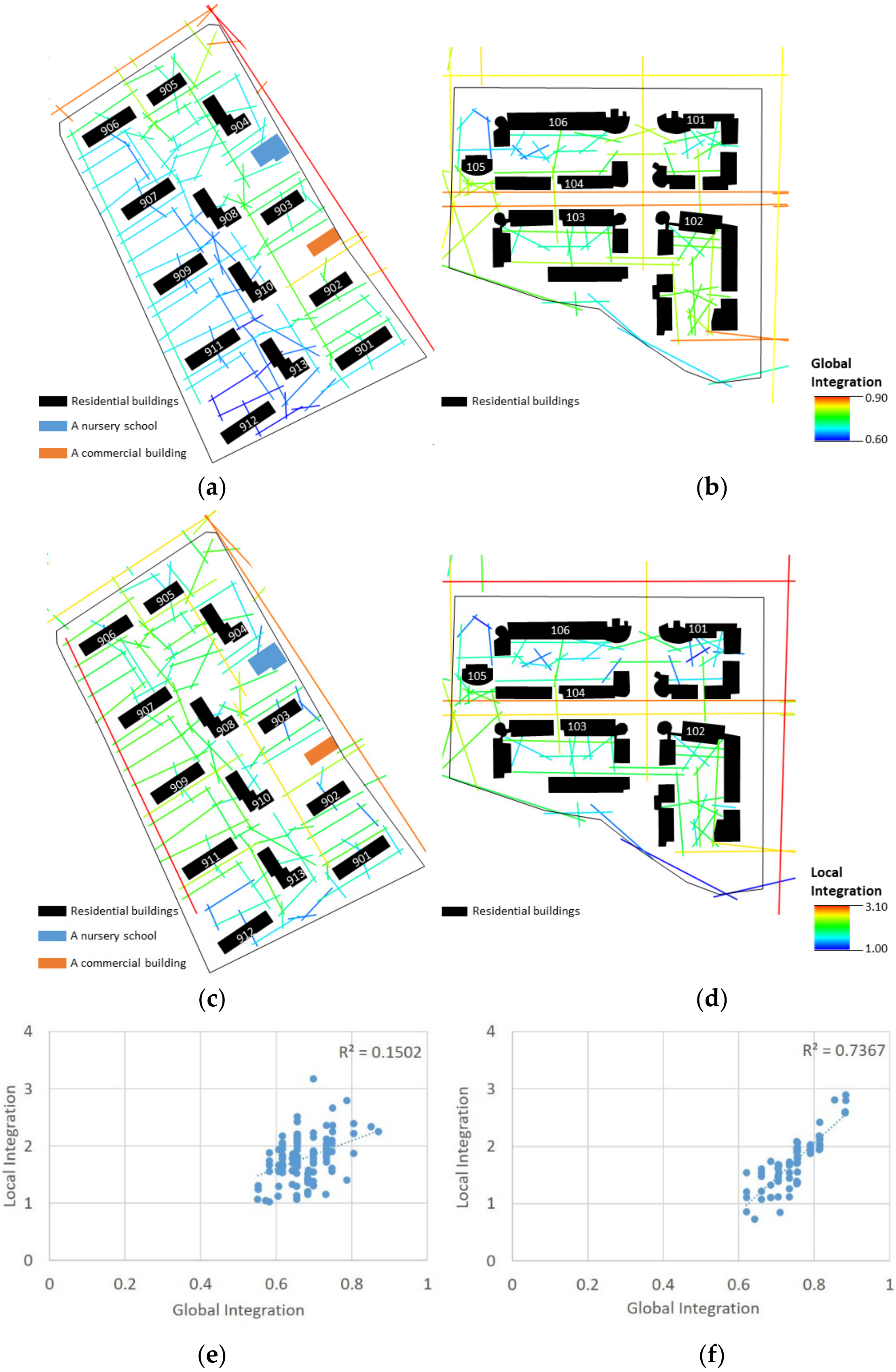


Figure 4. Comparison of the spatial configuration of Site A and Site B in terms of (**a**) global integration for Site A; (**b**) global integration for Site B; (**c**) local integration for Site A; (**d**) local integration for Site B; (**e**) intelligibility for Site A; and (**f**) intelligibility for Site B.

Table 3. The accessibility and hierarchy of space by function.

Space by Function	Site A		Site B	
	Global Integration (The Highest Percentage)	Local Integration (The Highest Percentage)	Global Integration (The Highest Percentage)	Local Integration (The Highest Percentage)
All	0.6732	1.7860	0.7436	1.7091
Main entrance	0.8051 (20.38%)	2.3918 (36.42%)	0.8681 (5.66%)	2.7037 (8.61%)
Children's playgrounds	0.6870 (57.38%)	1.9025 (54.63%)	0.7119 (65.09%)	1.5641 (61.32%)
Walking trails	0.6790 (59.90%)	1.6724 (69.78%)	0.7454 (52.35%)	1.7109 (54.53%)
Parking/ roadways	0.6678 (63.40%)	1.9025 (59.11%)	0.7975 (32.54%)	1.9566 (43.16%)
Residential buildings	0.6422 (71.42%)	1.5584 (75.07%)	0.7314 (57.66%)	1.5964 (59.82%)

Conversely, in the case of Site B, the global-integration value for residential buildings (0.8681) was the highest, followed by those for parking/roadways (0.7975), walking trails (0.7454), residential buildings (0.7314), and children's playgrounds (0.7119). Local-integration values for these facilities were in the same order. When entering this complex one approaches the residential buildings via parking/roadways, and the walking trails are entered from the main entrance.

The greatest difference between Sites A and B is the function of the central space and the accessibility of residential buildings. The central spaces at Site B are the roadways and walking trails while that at Site A is the children's playgrounds. There is also a difference in accessibility. Site B has higher accessibility than the average value, whereas Site A has lower accessibility than the average value for the children's playgrounds, which can be said to be the central space. This means that Site B has a clearer centrality and can be considered a road-centered complex structure. Additionally, Site A has very low accessibility of its residential buildings, whose isolated position (71.42%) is shown in the spatial hierarchy.

4.2. Effect of Characteristics of Individual Space Use on Interaction

4.2.1. Relationship between Space-Usage Pattern and Frequency of Interaction

The next step was to analyze the correlation between individual space-use patterns and the frequency of interaction to identify related factors. The space-usage pattern is the spatial configuration of the residential buildings and the frequency of use of community facilities. The spatial-configuration data analyzed in the previous section were used to represent the spatial configuration of the residential buildings, and the frequency of use of community facilities was based on the Korea Land and Housing Corporation report data. The spatial configuration is an indicator of global integration and local integration and community facilities include management offices, children's playgrounds, benches/pavilions, and walking trails.

Table 4 shows the results of an analysis of association between space-use pattern and interaction. The factors related to the number of neighbors are global integration and local integration, which are spatial-configuration indicators for residential buildings. Global integration appeared to have a positive relationship with interaction, and this indicates that people living in highly accessible spaces have a large number of nodding acquaintances. Conversely, the more isolated the living space from the surrounding area, the more nodding acquaintances people have. Community facilities are significant in the relationship, with interaction occurring in children's playgrounds and on walking trails. People who use children's playgrounds and walking trails have more nodding acquaintances.

Table 4. Analysis of association between space-use pattern and interaction.

		Management Offices	Children's Playgrounds	Benches/Pavilions	Walking Trails	Number of Neighbors	Global Integration	Local Integration
Management offices	Pearson correlation	1	0.144 *	0.098	0.136	0.080	0.071	0.013
	Sig.		0.040	0.165	0.054	0.255	0.315	0.857
Children's playgrounds	Pearson correlation	0.144 *	1	0.330 *	0.321 *	0.198 *	0.107	0.058
	Sig.	0.040		0.000	0.000	0.005	0.129	0.415
Benches/pavilions	Pearson correlation	0.098	0.330 *	1	0.440 *	0.004	0.002	0.013
	Sig.	0.165	0.000		0.000	0.955	0.981	0.856
Walking trails	Pearson correlation	0.136	0.321 *	0.440 *	1	0.155 *	0.172 *	−0.016
	Sig.	0.054	0.000	0.000		0.028	0.014	0.817
Number of neighbors	Pearson correlation	0.080	***0.198 ****	0.004	***0.155 ****	1	***0.223 ****	***−0.174 ****
	Sig.	0.255	***0.005***	0.955	***0.028***		***0.001***	***0.013***
Global integration	Pearson correlation	0.071	0.107	0.002	0.172 *	0.223 *	1	0.285 *
	Sig.	0.315	0.129	0.981	0.014	0.001		0.000
Local integration	Pearson correlation	0.013	0.058	0.013	−0.016	−0.174 *	0.285 *	1
	Sig.	0.857	0.415	0.856	0.817	0.013	0.000	

*: Significance level $p < 0.05$. Bold and italicized values represent the most meaningful results of this analysis.

4.2.2. The Effect of Space-Use Patterns on Interaction

Based on the results of the correlation analysis, a multiple-regression analysis was conducted to identify the extent to which the spatial configuration of the residence location and the frequency of use of community facilities affect the interaction. By considering collinearity, an optimal model was developed via using a stepwise method. The results are shown in Tables 5 and 6. The results for the three-step model include that the interaction is affected by the global and local integration of individual living spaces and the frequency of use of children's playgrounds. The relationship between the standard coefficients shows that the higher the accessibility of personal living spaces, the more isolated they are from the surrounding spaces, and the more a resident uses children's playgrounds, the more nodding acquaintances they have. Among these factors, accessibility appears to have the strongest influence on interaction.

Table 5. The results of stepwise multiple-regression analysis.

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0.223	0.050	0.045	2.681
2	0.334	0.111	0.102	2.600
3	0.380	0.144	0.131	2.557

Model 1. Predictors: (constant), global integration; Model 2. Predictors: (constant), global integration, local integration; Model 3. Predictors: (constant), global integration, local integration, and children's playgrounds.

Table 6. Coefficients for Model 3.

Model	Unstandardized Coefficients		Standardized Coefficients	t	95% Confidence Interval For β
	B	Std. Error	β		
(Constant)	−3.091	2.106		−1.468	0.144
Global integration	12.650	3.125	0.279	4.048	0.000
Local integration	−2.698	0.701	−0.264	−3.846	0.000
Children's playgrounds	0.410	0.148	0.183	2.764	0.006

4.3. The Difference in Interaction between Complexes with Different Spatial Configurations

The previous analysis suggests that spatial configuration affects the frequency of interaction. As shown in Section 4.1, Sites A and B have different spatial configurations. This is reflected in the site images shown in Figure 5. Focusing on the present situation of the boundary of the complex, images (a) and (b) show that Site A is disconnected from the city as it is surrounded by high retaining walls and plantations. The main entrance adjoins the commercial buildings, but the roadways are not connected to the inside of the complex (see (a)). Image (d) from Site B shows that the boundaries are partially created by plantations. The pedestrian passages to the main entrance are connected to the inside of the complex. Therefore, as previously mentioned, Site B is more connected to its surroundings than is Site A. Considering the children's playgrounds, image (e) for Site A shows that the nursery schools are next to the outdoor playgrounds but are enclosed by parking lots and fences. Image (f) was captured at the center of the complex and shows a weak connection with residential buildings. At Site B, images (g) and (h) show connections to the pedestrian passages or those located at the entrance to the residential buildings. Therefore, accessibility to the children's playgrounds at Site B is better than at Site A. With regard to walking trails, image (i) at Site A shows the complex plan focusing on the path of the cars, meaning that the walking trails are disconnected. Thus, people can be seen walking on the roadways. Image (j) shows an obscure walking trail in a residential building, although it is a trail and also has a bench and a pavilion. However, in image (k) at Site B, the walking trails are facing commercial buildings and thus function as a community street. The trail shown in image (l) is naturally connected to the residential buildings. Therefore, the trail at Site B provides an accessible and safe environment, making it easy to meet one's neighbors by accident. Regarding parking and roadways, the parking lots in image (m) at Site A are located in an important space enclosed by residential buildings. The pedestrian passages and roadways are separated in image (o) captured at Site B, and the pedestrian passages are secured without any disconnection. Image (n) from Site A and image (p) from Site B have the parking lots using decks. However, image (p) shows a separate space for the path of the cars, unlike image (n). This suggests that Site A is a vehicle-centered complex and that Site B is a complex with segregation of pedestrians and vehicles. There is an independent management office in the parking lot in front of the residential buildings in image (q) captured at Site A. In image (r), high-rise apartments are located along narrow pedestrian passages in front of the residential buildings. Image (s) from Site B shows a piloti on the first floor and bridges connecting the residential buildings at the second and third floors. In addition, there is the path that leads to the parking lot or third floor of the walking deck. Therefore, it is clear that Site B connects its residential buildings more closely.

Given these differing spatial configurations, whether residents in the two complexes differ in their interactions was analyzed using a *t*-test, with the results shown in Tables 7 and 8. The average number of nodding acquaintances across the sites involved those from 2.43 households. Site A had an average of 1.42 households and Site B an average of 3.35; thus, the residents of Site A had more nodding acquaintances than those at Site B. The significance of this difference was analyzed (see Table 8), not assuming equal variances for the two groups. This indicates that there are differences between the groups.

Table 7. The difference in interaction by complex.

	N	Mean	Std. Deviation	Std. Error of the Mean
Site A	97	1.42	1.069	0.109
Site B	105	3.35	3.419	0.334
Total	202	2.43	-	-

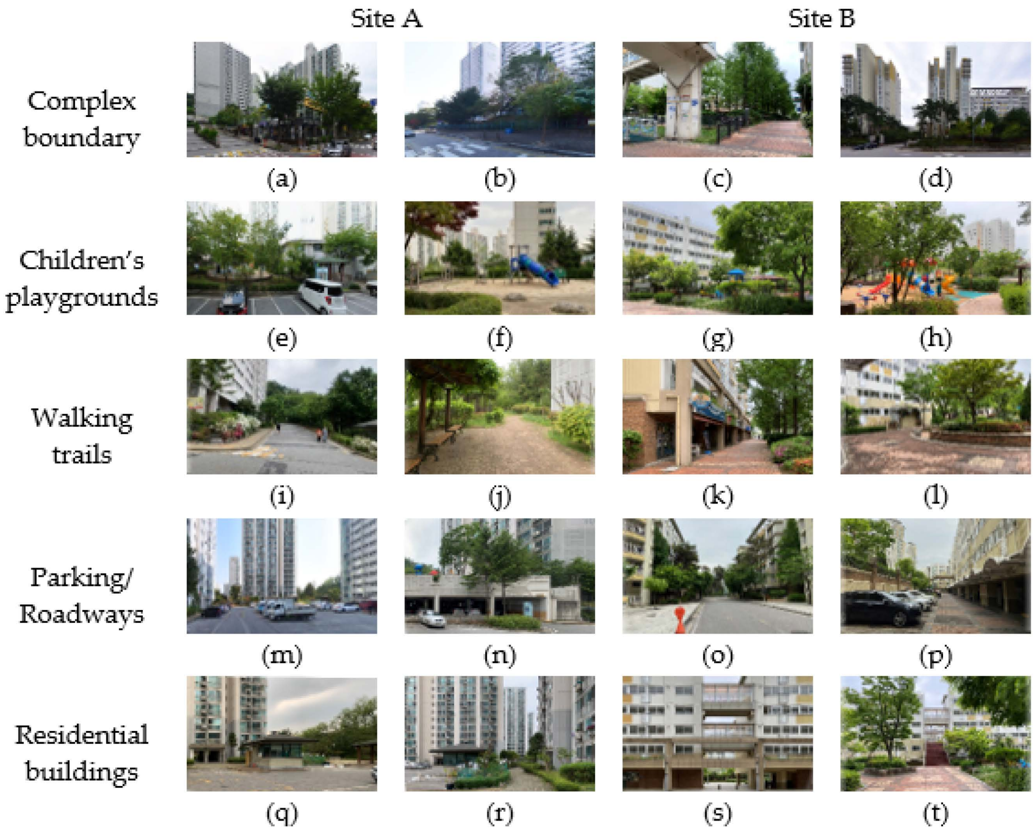


Figure 5. Comparison of the present situation at Sites A and B: (**a**) bounded part of the main entrance; (**b**) bounded part of the back entrance; (**c**) bounded part of the main entrance; (**d**) bounded part of the back entrance; (**e**) nursery schools and children's playgrounds; (**f**) children's playgrounds between residential buildings; (**g**) children's playgrounds enclosed by residential buildings; (**h**) children's playgrounds connected to trails; (**i**) disconnected walking trails; (**j**) obscure walking trails in residential buildings; (**k**) walking trails facing commercial buildings; (**l**) walking trails connected to residential buildings; (**m**) parking lots between residential buildings; (**n**) parking lots using slopes; (**o**) parking/roadways separated from pedestrian passages; (**p**) parking lots separated from walking decks; (**q**) management offices in front of residential buildings; (**r**) residential buildings of high-rise apartments; (**s**) residential buildings connected by a bridge; (**t**) residential buildings connected in three dimensions.

Table 8. Independent-sample test: different interaction between sites.

		Levene's Test for Equality of Variances		*t*-Test for Equality of Means				
		F	**Sig.**	***t***	**df**	**Sig. (2-Tailed)**	**Mean Difference**	**Std. Error Difference**
Number of neighbors	Equal variances assumed	53.403	0.000	−5.322	200	0.000	−1.930	0.363
	Equal variances not assumed			−5.499	125.640	0.000	−1.930	0.351

5. Conclusions and Discussion

This study analyzed differences in the spatial configuration and frequency of interactions between high-rise apartments—which are purported to cause social pathology—and newly attempted perimeter block housing in Korea. Considering that low-income families are sensitive to their physical environment [10], the target sites for this empirical research were selected from National Rental Housing sites where low-income families are concentrated. The study analyzed the frequency of interactions at both the individual and the complex level, with results as follows.

To analyze residents' space-use behavior, the spatial configuration of the residence location and the frequency of use of community facilities that determine behavior were measured. The correlation between the "spatial configuration of residence location," the "frequency of use of community facilities," and the "number of neighbors interacting" was analyzed. The global integration of residence location, the frequency of use of children's playgrounds, and the frequency of use of walking trails were related to the number of neighbors interacting; these all showed a positive relationship. In correlation analyses of factors influencing the interaction, global integration and the frequency of use of children's playgrounds were as significant.

The difference in interaction between these two complexes with their different spatial configurations was analyzed. Even though Site A is located in a place with moderate urban accessibility, the internal and external connections associated with its spatial configuration are weak, and the accessibility of its residential buildings is very low. Conversely, while Site B is located in a place with low urban accessibility, the internal and external connections of its spatial configuration are adequate; as a consequence, accessibility in the complex is high, as is accessibility of the residential buildings. In addition, its spatial hierarchy is systematically well formed. The comparison of residents' interactions in these two complexes with their different spatial configuration showed that Site B, where the spatial hierarchies are well formed, had better interactions.

The main finding of this study is that people living in the complex with a well-connected spatial configuration and those who frequently used children's playgrounds interacted more. Site A, with a well-connected spatial configuration, has adequate accessibility to individual residence locations and a well-formed spatial hierarchy. The results highlight four aspects for discussion in the context of previous studies of spatial configuration, space-use behavior, and frequency of interaction in National Rental Housing.

First, there was a difference in spatial configuration between the high-rise apartment and perimeter block housing. Among previous studies, those focused on the spatial configuration of high-rise apartments analyzed only the inside of residential buildings or were based only on the living unit, with no analysis of the outdoor space (ground floor) where a sense of community is created [44–47]. Therefore, previous studies on the spatial configuration of high-rise apartments did not identify how interactions between neighbors occurred. However, as Newman argues [7], the results of these studies verify the absence of semi-public and semi-private spaces. In other words, considering the spatial hierarchy inside the complex, there are few spaces with orange or yellow axes such as Site A, indicating intermediate values of accessibility. Studies on the spatial configuration of perimeter block housing present many findings regarding interactions between neighbors. In particular, Kong et al. [18] analyzed a European block complex and found that the space-occupancy rate of the roads surrounding the complex ranked in the top 10%, and the space-occupancy rate of courtyards ranked in the top 50%. A similar result was obtained in the current study. Therefore, although this study used a residential area in Korea as an example, it has a similar spatial configuration to that of a general perimeter block housing complex, as seen in theory and in European cases. In addition, the spatial configurations of the high-rise apartment and the perimeter block housing were shown to be clearly different.

Second, the spatial-configuration indicator that represented interaction was the global integration of the living space. People living in the complex with good accessibility from the outside had many nodding acquaintances. However, in Kim and Kim's study [8], the indicator related to interaction was local integration. Since their study included only one complex, and did not include a city, it was acknowledged that the local indicator was more relevant as the study considered only movement inside the complex. The scope of the current study included a city, and it compared complexes with different urban accessibility, unlike Kim and Kim's study. Additionally, local integration, which reflects accessibility between internal spaces showed no difference between complexes in the current study.

(The significance of Levene's test for equality of variances was 0.001, and the significance of the *t*-test was 0.415.) Therefore, it was important to analyze the interaction with global integration in this study, which showed that people in the complex where they encountered many other people had more nodding acquaintances.

Third, the community facility that affected the interaction was children's playgrounds. Although a community facility induces people's interaction, it is known that more than 77% of residents of public rental housing rarely use community facilities [48]. Nevertheless, the frequency of community use of public rental housing affects interactions [42]. Thus, this study examined the frequency of use of management offices, children's playgrounds, bench pavilions, and walking trails as community facilities. This revealed that the facilities that correlated with the interaction were children's playgrounds and walking trails. A previous study showed that, among community facilities, children's playgrounds are the sites of the most interaction activity [40]. Moreover, in a rental housing complex, unlike in a condominium complex, residents who use walking trails often have a strong tendency to meet neighbors [41]. This provides a supportive basis for explaining the results of the current study. However, in this study, only children's playgrounds were significant among the community facilities that influenced interaction, which is because people stayed there longer and had more opportunities to meet their neighbors than when using walking trails.

Fourth, residents of complexes with different spatial configurations had different frequencies of interaction. In typical apartments, the number of nodding acquaintances is less than five households [49]. In the case of permanent rental housing, where the lowest-income class resides, this number is even lower: one to two households [50]. The study area in the current research is a place where people with incomes lower than those in ordinary apartments, but higher than those in permanent rental complexes, live. The average of nodding acquaintances was 2.43 households. This means that the lower their income, the fewer neighbors people interact with. In a situation where these economic factors were controlled, the interaction of residents in complexes with different spatial configuration was compared here under the premise that spatial configuration affects interaction. This premise from previous studies was confirmed by the results of this study. Thus, it has been demonstrated that people who live in complexes with more definite and systematic spatial configurations interact more with their neighbors.

Overall, this study is valuable as it is the first to quantitatively demonstrate that perimeter block housing is more advantageous for interaction than are high-rise apartments. This study had limitations in generalizing to the global situation, since it deals with the case of Korea. Nevertheless, developed countries have experienced social pathology because of the construction of high-rise apartments, and the findings here can be used as basic data to quantitatively explain the current preference of planners for block-type complex. Developing countries such as Hong Kong, China, and Singapore are developing a large number of high-rise apartments, and they have the same potential that the spatial arrangement of their buildings might create social problems for people as does Korea. Future research comparing social interactions in high-rise apartments and perimeter block housing in other countries to find a way to solve social and spatial problems is necessary. This study provides an evidence base for changing the paradigm of public-housing planning in Korea. In addition, the findings can be used as basic information for healthy community housing design in the future planning of public rental housing.

Author Contributions: Conceptualization J.Y.K. and Y.O.K.; methodology, J.Y.K.; formal analysis, J.Y.K.; investigation, J.Y.K. and Y.O.K.; resources, Y.O.K.; data curation, Y.O.K.; writing—original draft preparation, J.Y.K.; writing—review and editing, J.Y.K.; visualization, J.Y.K.; supervision, Y.O.K.; project administration, Y.O.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Restrictions apply to the availability of these data. Data was obtained from the Korea Land & Housing Corporation and are available from the corresponding author with the permission of the Korea Land & Housing Corporation.

Conflicts of Interest: The authors declare no conflict of interest.

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