

From Enclave Urbanism to Sustainable Cities: Comparing Gated and Non-gated Housings Form in China from Syntactical and Morphological Perspectives

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Abstract

Aiming to achieve more sustainable cities, a new directive issued by China's government in 2016 announces an upcoming housing reform to halt new gated housing constructions and gradually open the built-up ones. Since then, researchers have been focusing on the policy, management, and benefits of un-gating residential areas. However, there is a need to understand the gated and non-gated housing form through a spatial perspective beyond the physical boundaries. This paper thus attempts to address this point by adopting approaches from space syntax and urban morphology. Taking Wuhan City as a case study, analyses were conducted at three levels. Investigation at the macro level focuses on the overall distribution of gated residences in the urban area and the social logic behind it. At the meso level, six pairs of cases (i.e., twelve cases) were carefully chosen to compare their density and typomorphology via Spacemate diagram. Moreover, two pairs of cases were further selected to compare spatial centrality and movement interface using the space syntax approach. The findings suggested that the distribution of gated housing corresponds to the evolution process of the city. Moreover, the Spacemate diagram also evidenced that compared with non-gated ones, gated estates tend to create a larger proportion of open space for a smaller number of residents. Finally, the non-gated layouts demonstrated higher centrality and greater movement interface than gated layouts at the local, neighbourhood, and city scales. This indicates that the non-gated estates have better connections and embeddedness to the surroundings and a greater probability for encounters. Therefore, simply removing gates or physical boundaries may not change the performance of a gated compound, as its inherent spatial structure would remain the same. This paper provides a new perspective to understand better the gated housing forms and suggestions for the ongoing housing reform in China.

Keyword: Housing Form, Gated Housing, Space Syntax, Urban Morphology

Introduction

Gated residences are arguably the most influential and meanwhile controversial housing form in modern society. This housing form has been deeply rooted in China's culture and history, reflecting collectivism and authority centralization since the feudal era. Consequently, Chinese cities have evolved as spatial patchworks of distinct and internally homogeneous territorial units, known as enclave urbanism (Wissink and Hazelzet, 2016). However, the drawbacks of this urban form became increasingly severe for China's central government to declare the prohibition of gated residences in 2016. Since then, China has witnessed a growing number of studies on domestic gated housing areas, with topics ranging from the driving force to the rationale of un-gating, from the challenges to potential traffic benefits from un-gating. However, there is a need to investigate China's gated residences from an architectural perspective, focusing more on structural rather than physical features.

This paper is part of Doctoral research on how gated housing forms affect urban vitality through the lens of spatial usage patterns. Due to the space limit, this paper only presents the findings from housing form analyses. The research question aimed to address here is "if and how gated and non-gated housing forms differ from each other, apart from physical boundaries". The results of this paper emphasized that the gated residence is not merely about physical boundaries; that is, other spatial aspects are worth greater attention for creating more sustainable cities. This paper helps better understanding housing forms in China and is conducive for ongoing housing reform in China.

Background

In western academia, the gated housing form is generally blamed for exacerbating social segregation, loss of public space, uneven provision of public services, and traffic congestion. On the other hand, some studies have suggested positive effects of "gated communities" on the sense of community, the perception of safety and the poor nearby, albeit these voices are relatively small compared to the criticism (for systematic review, see Blandy et al., 2003). Noteworthy, so far, these topics remain in hotly debates, and the evidence from empirical studies remains inconsistent and inconclusive. This is probably because these residential enclaves' social impacts are context-specific (He and Wang, 2019), as they are developed hand in hand with local values, beliefs, and practices.

Unlike the "gated communities" in the west driven by the fear of crime or club goods theory (Webster, 2001, Low, 2004), residential enclaves have deep historical and cultural roots in China (Wu, 2005). Additionally, western "gated communities" and China's gated compounds also distinctly differ in their morphology. Miao (2003), for example, stated that compared to its US counterpart, China's gated residence tends to have a larger population and plot area and a higher floor area ratio (FAR). Meanwhile, she also pointed out that American gated communities have a greater variety of layout and structures, whilst China's modern gated compounds are more standardized. Despite these differences, both western "gated communities" and China's "gated residences" are arguably characteristics of the "enclosure, repetition, and hierarchy" that criticized by earlier space syntax research as the destruction of urbanity and the source of social malaise (Hillier, 1988, Hillier, 1996).

Methodology

The methodology involves three stages. Firstly, mapping techniques were used to reveal the gated compound distribution within the research area. Based on Baidu Street View imagery (<http://map.baidu.com/>), all housing areas were classified into gated and non-gated categories. A residence was considered gated if it has physical boundaries (e.g., iron fences, gates), security guards, or any sign suggesting "residents only".

Additionally, a historical map of city evolution was also conducted to help better understand the logic of gated estate distribution.

Secondly, to compare typomorphology between gated and non-gated housing areas, six comparative groups were further selected (circled in Figure 1). Two cases within the same group have proximity and share a similar size, construction year, and housing price. A more detailed introduction of the selected housing estates was reported elsewhere (see Yang, 2021). These housing areas were then analysed through Spacemate Diagram. This diagram simultaneously demonstrates four indicators of the estates: Gross Space Index (GSI), Floor Space Index (FSI), Open Space Ratio (OSR), and storey number (L) to reflect compactness, intensity, pressures on non-built space, and height respectively (Berghauser Pont and Haupt, 2007).

Thirdly, space syntax techniques were applied to compare street configuration within two groups of cases (Group 1 and 2 in Figure 1). Normalized angular Integration (NAIN) and Choice (NACH) measurements were computed in Depthmap (Hillier et al., 2012). While the former measures how close a street segment is to all others (i.e., closeness centrality), the latter measures how likely a segment falls on the shortest path from everywhere to everywhere else (i.e., betweenness centrality) in a system or a given radius. The segment analysis was computed at three radii: 400, 1200, and 8000 meters, representing extremely local, neighbourhood and city scales, respectively. Note that the model used for analysis covers the whole city to avoid any "edge effects". The

means of NAIN and NACH were then compared across the cases using bootstrapped independent samples *t*-tests (20,000 iterations and 95% confidence interval). The difference in means was considered statistically significant when the *p*-value of the *t*-tests is less than 0.05. Moreover, correlations between NAIN and NACH at the same radii were computed to measure the overlap of potential to- and through-movement (Vaughan et al., 2009).

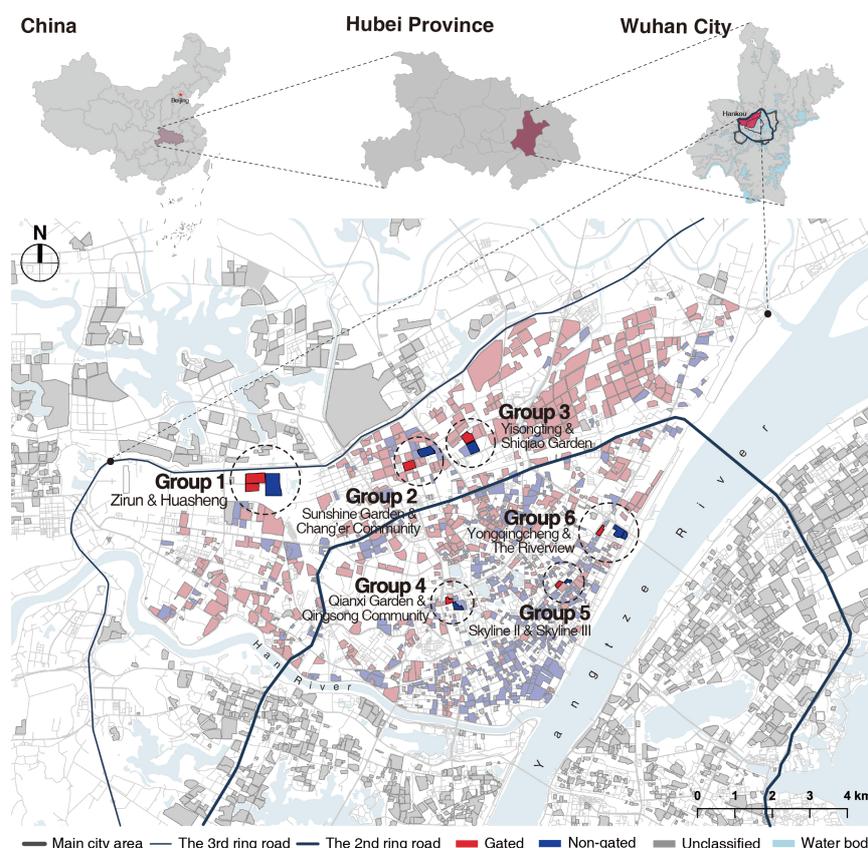


Figure 1. A map shows the location of the study site and that of gated as well as non-gated residences within this area. Six comparative groups circled were used for further analysis.

Results and Discussions

Distribution of Gated Housing Areas

Figure 1 demonstrates the distribution of gated and non-gated housing estates within the research area. Based on visual inspections, more non-gated housing estates are found within the 2nd ring road, whilst the area beyond this line is dominated by gated ones. More strikingly, both the number and size of gated housing estates gradually

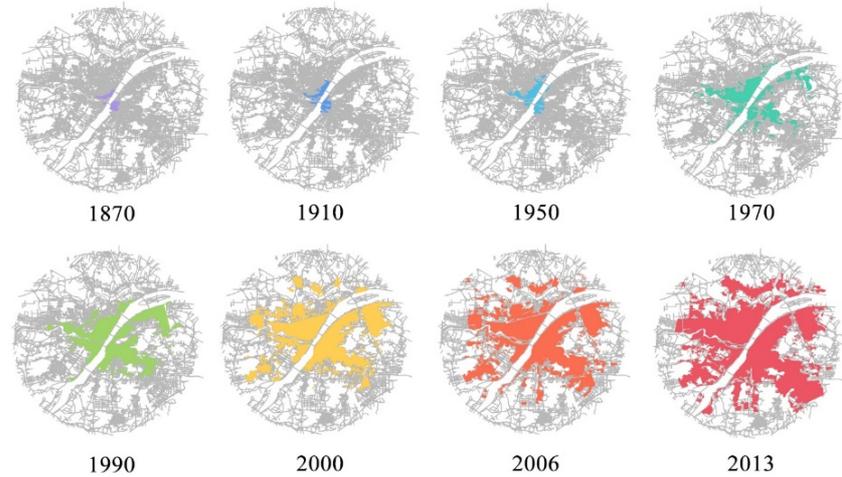


Figure 2. A map shows the historical evolution of the city from 1870 to 2013.

increase from the confluence of the Yangtze River and the Han River to the rest of the city. This can be explained by Figure 2, which mapped out the city's built-up area in different years. The city first emerged along the rivers and has been expanding outward in a radial pattern. This suggests a correspondence between the gated housing distribution and city evolution process: more gated estates are located in more recently built areas.

Correspondences were also found between the gated housing distribution and building density and block size. The old historical area where most non-gated residences are located has the highest building density and the smallest block size (Figure 3). Because this area was a concession from the late 19th century to the early 20th century, the urban and architectural forms were heavily influenced by western styles, such as non-gated housing and small blocks. However, more recently built areas that are taken over by gated compounds tend to show lower building density and larger block size. This visual inspection arguably suggests how gated housing construction has bred China's enclave urbanism.



Figure 3. Morphological analysis of building density (left) and block size (right) in the study area.

Spacemate analysis of twelve cases

This section analysed twelve selected housing areas through the Spacemate diagram (Figure 4). The diagram correctly suggested that all case studies belong to urban and highly urban types and that housing estates are high-rising or mid-rising. Notably, Yongqingcheng stands out as an outlier from the other cases, which has an extremely high FSI, which may cause overcrowding and social withdrawal issues.

The table in Figure 4 summarised the results of all six groups, where shaded cases indicated non-gated housing estates, and the higher number within each comparative group was highlighted in bold. Despite the variances, non-gated estates generally showed higher FSI and GSI but lower OSR. This result is not surprising because the real estate companies aim to make a profit by providing a greater amount of open space and resources to a smaller number of people. However, this may lead to many underused facilities and spaces within the compound. In short, the Spacemate diagram generally revealed typomorphological differences between gated and non-gated dwellings.

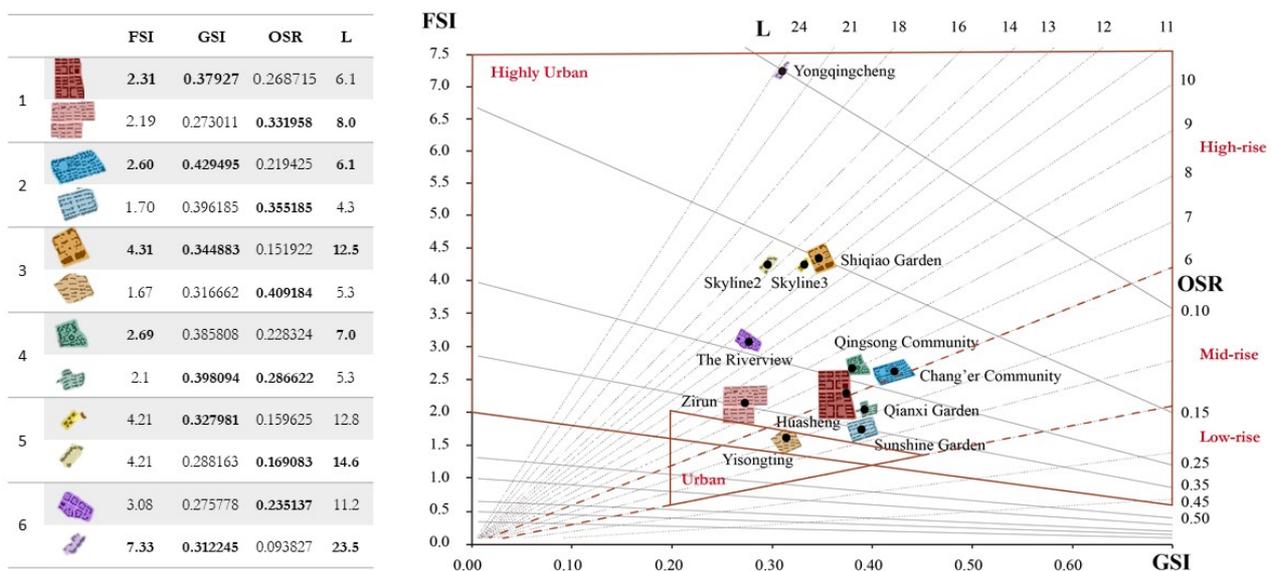


Figure 4. Spacemate diagram shows the typomorphology of twelve selected areas (in six groups) through Floor Space Index (FSI), Open Space Ratio (OSR), Gross Space Index (GSI), and the number of floor layers (L). Note that all housing estates' layouts are presented on the same scale to reflect the lot size.

Space syntax analysis of four cases

Figure 5 displayed street centrality (i.e., NAIN and NACH) for two groups of cases. Streets with higher centrality were shown in warmer colours. Both groups are located near the 3rd ring road (Figure 1). Zirun and Sunshine Garden are gated, while Huasheng and Chang'er Community are non-gated.

Regarding average NAIN, two non-gated cases generally demonstrated higher means than their counterparts across three scales, which was further confirmed as statistically significant through bootstrapped independent samples *t*-tests (Table 1). This finding suggests that the non-gated housing layout is overall more accessible as destinations (or origins) for residents, people in the neighbourhood, and vehicles.

A different picture appeared for the average NACH. Both comparisons within groups were not statistically significant, with the p-value higher than 0.05 (Table 1). This is not surprising. Firstly, all cases contain cul-de-sacs (dark blue segment) that cannot afford any through-movement (i.e., NACH equals zero). Furthermore, residential areas belong to the city's background network and act more as destinations (origin) for people going to (from) rather than passing through.

However, gated cases demonstrated slightly higher through-movement potentials at the extremely local scale (R400) but lost their power at larger scales (R8000). This suggests that opening the currently gated

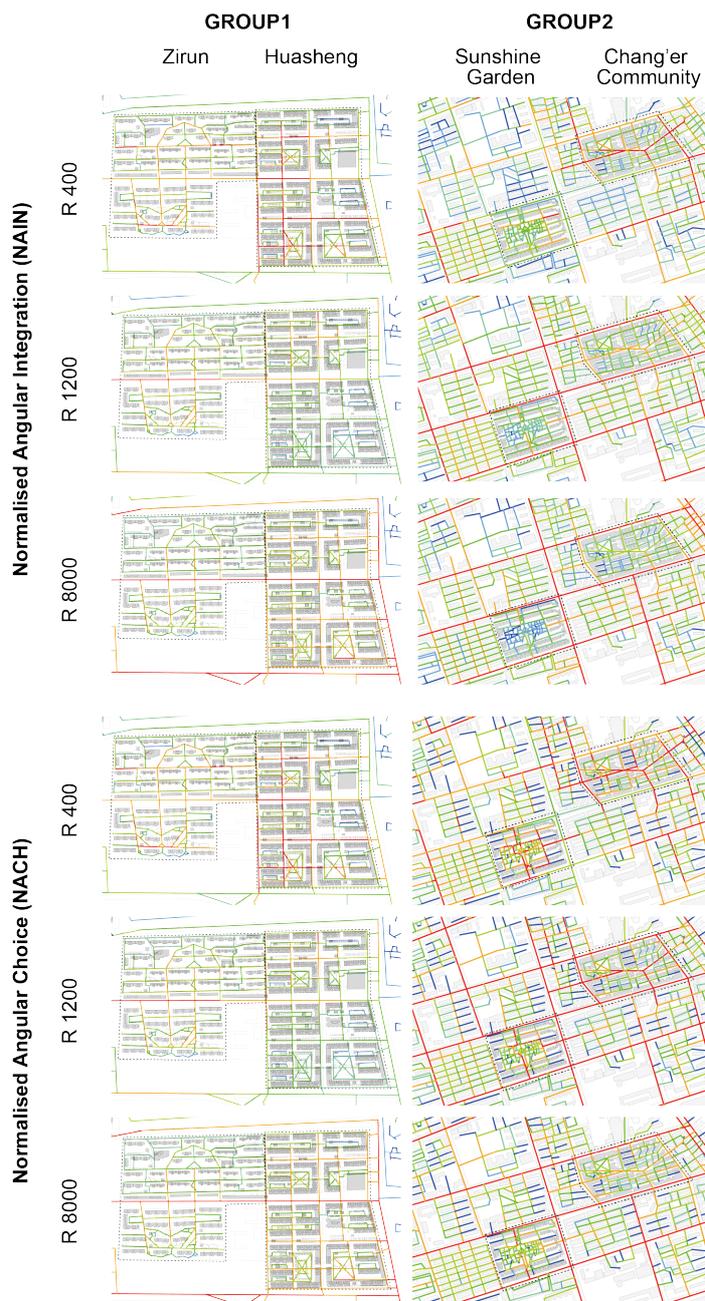


Figure 5. Angular segment analyses show the movement potentials of four cases across scales. Warm colours represent high values.

estates does help create more direct and shorter paths for people to move around, albeit only at an extremely local scale. For people walking from a further distance of the neighbourhood (R1200) or vehicles (R8000), the through-movement potentials would remain lower.

As for correlations between NAIN and NACH, two non-gated cases showed remarkably higher coefficients (Table 2). This finding implies a greater overlap between potential to- and through-movement in non-gated settings. What is even more striking is that for non-gated areas with internal streets only, the coefficients remained higher than their gated rivals with periphery included. However, for gated cases, without the periphery, the proposition of movement interface fell apart. Thus, we can conclude that the non-gated housing areas tend to provide a layout that creates a greater overlap between different movements, thus a greater probability for interactions between people who are *going to* and *passing through* the area. Conversely, the gated compounds are more likely to

separate movement and generate a sparser co-presence pattern among people.

Table 1. Bootstrapped independent samples t-tests (20,000 iterations, 95% confidence interval level) compare the mean of NAIN and NACH within two groups. Numbers in *Italic* within parentheses are *p*-values, and statistically significant results of the t-tests are highlighted in bold.

			Normalized Angular Integration (NAIN)			Normalized Angular Choice (NACH)		
			R400	R1200	R8000	R400	R1200	R8000
Group 1	Zirun	Gated	1.1372424	0.9323609	1.0106388	0.9118825	0.8473946	0.7742523
	Huasheng	Non-gated	1.2066002	0.8414817	1.1082223	0.9055070	0.8423030	0.8149623
Bootstrapped independent samples t-tests			- 2.832 <i>(0.004)</i>	6.009 <i>(0.000)</i>	- 8.824 <i>(0.000)</i>	0.190 <i>(0.850)</i>	0.156 <i>(0.877)</i>	- 1.357 <i>(0.179)</i>
Group 2	Sunshine Garden	Gated	1.0640954	0.9346700	1.1948163	0.9898362	0.9339380	0.8693348
	Chang'er Community	Non-gated	1.1326531	1.0565114	1.3210678	0.9891388	0.9526554	0.8928075
Bootstrapped independent samples t-tests			- 3.055 <i>(0.002)</i>	- 6.170 <i>(0.000)</i>	- 7.254 <i>(0.000)</i>	0.021 <i>(0.983)</i>	- 0.578 <i>(0.563)</i>	- 0.772 <i>(0.440)</i>

Table 2. Movement interface of four housing areas, measured by correlation coefficients between NAIN and NACH at the same radii.

				R400	R1200	R8000
Group 1	Zirun	Gated	Internal and peripheral	0.661	0.647	0.561
			Internal only	0.540	0.621	0.515
	Huasheng	Non-gated	Internal and peripheral	0.702	0.505	0.626
			Internal only	0.710	0.504	0.603
Group 2	Sunshine Garden	Gated	Internal and peripheral	0.508	0.523	0.488
			Internal only	0.510	0.447	0.358
	Chang'er Community	Non-gated	Internal and peripheral	0.691	0.700	0.670
			Internal only	0.671	0.650	0.567

Conclusions

This paper has investigated the distribution, typomorphology, and configuration of gated residences in Wuhan city through multi-scale analyses. The findings suggested that the gated housing distribution corresponds to the city's evolution process, resulting in the uniqueness of China's enclave urbanism. Moreover, this paper also found that gated compounds tend to offer a greater proportion of open space on the ground floor as a selling point, which may lead to the low efficiency of space and facility usage. Additionally, from a syntactical perspective, the results indicated higher centrality for non-gated residences at all scales, although this difference was only statistically significant for the closeness centrality (Integration). Lastly, the movement interface analysis implied that the layout of non-gated residences provided a greater probability for encounters and interactions amongst different types of pedestrians, whilst gated compounds

tended to separate people from each other and thus interrupt users' interface. It is conjectured that these invisible, structural differences would affect people's perceptions and behaviours and thus spatial culture. These findings provide new empirical evidence for better understanding the gated housing form in China and can be used by urban designers, policymakers to (re)construct sustainable residential areas in the future.

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