

Planning review on residential environment of low-rent housing: a method to solve low-rent housing space insufficiency in Tianjin, China

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Abstract: Globally, there has been a substantial increase in the number of people who are not able to buy their own dwellings due to the phenomenal appreciation of real estate prices in China. With the growing worldwide demand for low-rent housing and the importance of supporting and stimulating sustainable development, the need for sustainable solutions in the low-rent housing sector is at a peak. For achieving new design methods for low-rent housing, we attempted to employ a practical project to explore the residential environment from the viewpoint of the Chinese national green building standards and municipal low-rent housing policy. Firstly we investigate the low-rent housing residential area in Tianjin, China. After a questionnaire and interview of local residents has been conducted, the characteristics of the residential environment are analysed. We consider that the outdoor space of low-rent housing could be diversified to partly fulfil interior functions, by which way the cost of the low-rent housing could be reduced to a certain extent.

1. INTRODUCTION

In this work we attempt to find out how the planning regulations can provide a solution by using public space for solving housing space insufficiency to improve residential environments in China. For this, we reviewed the planning system regarding the Chinese Green Construction Standard for exploring the environmental design guidelines of low-rent housing, residential areas. As a result, the design guidelines of low-rent housing environments balances public space and housing space for community communication in residential environments from the viewpoint of indoor and outdoor spaces.

Regarding policy measures for low-rent housing, the definition of housing affordability was used to overcome the difficulties for accessing acquisition of new housing buildings ([Hulchanski, 1995](#)). The rising need of housing is also a reflection of the difficult situation that individual households confront with affordable housing issues because of the rising cost ([Edward et al., 2005](#)). Chinese cities with high density development undergoing rapid urbanization processes often lack green space ([Jim, 2002a](#)), particularly in low-rent housing areas. Most Chinese low-rent

residential areas are developed under an intensive urban policy and planners have tried to create high density and low-rent housing to confront the fast population growth since the 1980s, while during the 1990s a good amount of cities augmented greening space programs, which need considerable financial support to maintain the green spaces in low-rent housing areas.

Recently, the compact city has become a term for a sustainable urban form that has control of urbanization and at the same time controls natural land use areas ([Beatley, 2000](#)). In cooperation with human activity, natural land use areas, especially along the edge of the countryside, need to be enlarged ([Swenson and Franklin, 2000](#)). Some research reports in the fields of environment and ecology provide suggestions on an optimization of environmental space utilization within conservation, consumption and improvement ([Forman and Godron, 1986](#); [Dramstad et al., 1996](#)). Some design concepts of spatial arrangement have been conducted effectively in environment landscape projects and urban planning designs ([Goldstein et al., 1982/1983](#)). For example, many studies have proposed landscape design concepts which are composed of linear mosaic elements to enlarge the possibilities of connection of the land, including green plants for urban inhabitants, including small living creatures, in order to create a harmonious natural living environment ([Ahern, 1991](#); [Walmsley, 1995](#); [Mazzotti and Morgenstern, 1997](#); [Quayle and Lieck, 1997](#); [Flores et al., 1998](#); [Schrijnen, 2000](#)). However, few research reports focus on the functions of green space for improving housing space insufficiency with a viewpoint of indoor and outdoor community communication in low-rent residential areas.

So far, housing space insufficiency research has been conducted on comprehensive low-rent housing design and planning in the environment of high density developments ([Jim, 2002b](#)). In the European and American developed countries, there has been little research on housing space insufficiency and it is difficult to find typical references to the practice in China. Regarding housing morphology related to low density or scattered layouts, the studies on residential area landscapes mostly focus on residential garden type, which is not directly applicable for low-rent housing in uptown areas with high density. Although the landscape design is not specifically for low-rent housing environments, its application to residential environment improvement is possible in order to find some solutions for housing space insufficiency in low-rent housing areas.

In recent years in China, there has not been any official national regulation of low-rent housing development. Although the establishment of the system of low-rent housing in China has been around more than ten years, there is no literature discussing housing space insufficiency as one of the planning issues of low-rent housing. Only 18 papers in the Chinese National Knowledge Infrastructure (CNKI) database can be retrieved when searching for "low-rent housing" and "design", thus little literature can be found about low-rent housing planning and design guidelines on residential environments. Moreover, low-rent housing has been discussed in recent years in developing countries ([Bajunid and Ghazalib, 2009](#)), addressing the problem through a sociological viewpoint for reviewing the crisis of poor families. For finding a possible solution to residential environments in low-rent housing areas, the objective of this paper is to review how landscape design can be a new method for balancing housing space insufficiency due to the limited cost for low-rent housing, to improve the living quality of the residents.

2. APPROACH

For achieving a new design solution for residential environments in low-rent housing areas for housing space insufficiency, we investigate the low-rent housing residential area in Tianjin, China. We consider that the outdoor space of the low-rent housing could be diversified to partly fulfil the interior functions.

In this paper, we attempt to find a solution for housing space insufficiency in low-rent housing areas based on the Green Construction Standard for residential environments. With interviews of the local residents, the characteristics of the residences towards housing space usages are analysed. A couple of design solutions are given respectively for each problem in the existing low-rent housing environment and an evaluation of the design solutions is discussed based on the case study.

The remainder of this paper is organized as follows: Section 3 describes the research area and investigation information details; Section 4 discusses the liveability requirements of the residential environment in low-rent housing area based on the interview investigation with residents; in Section 5 and 6, design solutions are reviewed according to the national Green Construction Standard; and finally, in Section 7, a brief conclusion is given and future work is discussed.

3. INVESTIGATION AND STUDY AREA

For understanding what kinds of design guidelines on landscape design and public space are possible for solving the problem of housing space insufficiency, a field survey and interview have been conducted in Tianjin.

Tianjin is ranked as the fourth largest city in China. Tianjin's GDP reached 1.12 trillion Yuan in 2011, an increase of 16.4 percent from 2010. The city of Tianjin recorded China's highest per-capita GDP with \$13,393, followed by Shanghai with \$12,784 and Beijing with \$12,447.

For this investigation, the current conditions of the study area related to location, traffic, landscape, space intensity, facilities for the disabled and sense of belong have been summarized in *Table 1*. As summarized in *Table 1*, RuiXian Yuan and RuiXiu Yuan are typical projects of low-rent housing built in 2005 and 2006 in Tianjin, China, which are located in the suburb of HongQiao District. The buildings are six-storeys with each apartment 40-50 square meters. Most of the apartments are low rent housing, managed by the department of housing management of the local government. The residents who meet the conditions for low-income groups can be selected to live in the apartments. Since most of the apartments were built by the local government for low-income groups, the budget for the maintenance of the building management is limited.

Table 1. Current conditions of the study area

Field Investigation	Photograph	Current Conditions	Analysis
Location		Most of the apartments are built by the local government, there are not enough funds to maintain the building.	The design should consider the sustainability of the construction budget and the sustainability of low-cost maintenance.
			

Traffic		<p>The residential location is on the edge of the city, however, the convenience of reaching the city centre has been considered, so it's next to a station.</p>	<p>Maintain the current status</p>
Landscape		<p>Not enough green plants in the environment.</p>	<p>Consider vertical and group greening plans to form effective damage resistance.</p>
Space Features		<p>Outdoor space is crowded, while interior space is narrow.</p>	<p>Maximize the efficiency of the space, interlace the activity space, resting space and walking paths.</p>
Facilities for the Disabled		<p>Most facilities in the park facilitate are for the disabled and the elderly.</p>	<p>According to the budget, at least achieve the basic standards for the disabled.</p>
Sense of Belonging		<p>The public stigma of poor people concentrated in one location is still to be solved.</p>	<p>Beside the design, also consider housing residents psychological factors</p>

4. LIVING NEEDS ANALYSIS OF LOW-RENT HOUSING ENVIRONMENT

4.1 Indoor and Outdoor Factors

We conducted a field survey in October 2009 in the study area, which mainly focused on the different aspects of the living needs of low-rent housing environment residents. The interview survey follows Maslow's hierarchy of needs (Maslow, 1943) to examine the different needs of residents, which are the physiological needs, social communication needs, aesthetic needs and needs regarding a sense of self-worth. The majority of the residents are elderly or disabled (See Figures 1 and 2, below). Thus, the interview was chosen as a method to investigate residents' opinions in the study area. Limitations to the interview included their education level and the health condition of the elderly (bad hearing, weak eyesight), meaning they could not understand the questions properly during the questionnaire. In this interview survey, 26 residents were chosen; however, the effective answers received were from only 11 healthy residents, consisting of seven

elderly and four youth under 18. We tried to figure out the living needs in both the indoor and outdoor housing environments.

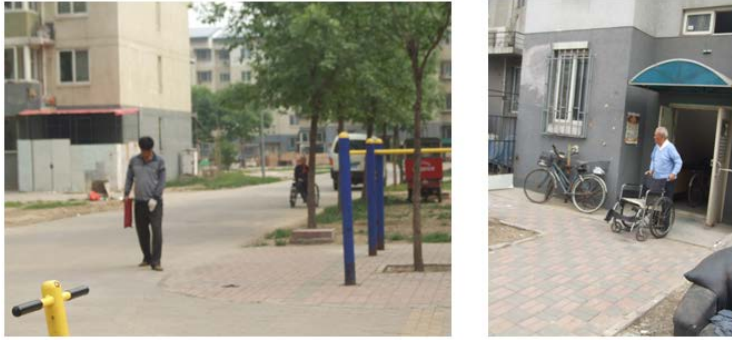


Figure 1. The elderly or disabled residents in the study area

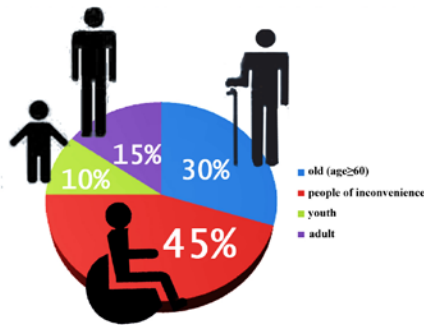


Figure 2. Ruixiu Yuan age structure percentage (from the community service center)

Based on the interview, most problems of the housing environment point to the insufficient indoor space and lack of outdoor space. Problems of environmental scene and management are mentioned during the interview, which are not as strong as the issue of insufficient indoor space. All the responders suggested strengthening the communication function in public spaces instead of indoor spaces. Thus, the communication function that is difficult in indoor space is actually fulfilled by the outdoor space in this study area.

Other responders argued for aesthetic demand and sense of self-worth, which are not related to our purpose in the paper and will not be discussed further in the remaining parts of this paper. *Figure 3* is a psychological structural model that summarizes the field survey, which we will discuss in detail in the following sub sections.

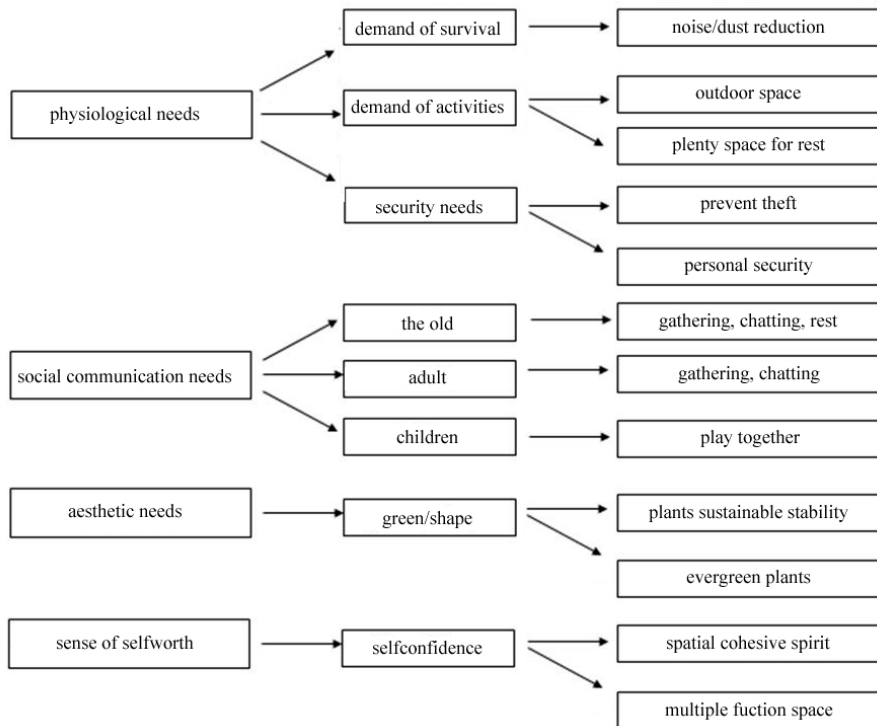


Figure 3. Living needs between indoor and outdoor spaces in the study area

4.2 Physiological Needs

Physiological demand is the physical priority demand of human beings for survival, which is also the basic requirement for a living environment. It includes fresh air, good ventilation, plenty of sunshine, suitable climate, no interference noise and so on.

4.2.1 Survival Needs

First of all, the residents do have many dissatisfactions with the current environment. 10 of the 11 interview responders think the problems of current concern are related to the indoor space.

The core problem from the responders concentrates on the indoor space insufficiency as the indoor space is where the residents actually live. In small rooms filled with all kinds of stuff (See Figure 4), residents feel depressed by there being barely any room for sitting. This issue further influences on their communication with their visiting guests because of the physically impossible space, which is mentioned by more than half of the responders. The residents have no alternatives for this situation.



Figure 4. The insufficiency of the indoor space

There is no good building management, so indoor water leakage, water plugging and other problems were also highlighted during the interview. According to the interview, some of the first floors of the building always have water on the floor. As shown in *Figure 5* on the following page, there are drainpipes installed from the second or third floor because of water plugging.



Figure 5. The drainpipes installed from the second or third floor

4.2.2 Activity Needs

Space is demanded for all kinds of outdoor activities in residential environments. In the daily life of the residents, outdoor activities may widely include rest, sports, recreation, fitness and a series of other activities that are done in the outdoor space environment.

In low-rent housing, the majority of the residents belong to the elderly population who like to stay with their grandchildren in outdoor spaces, therefore more outdoor space for both sitting and being active is needed. In the interview, seven elderly people suggested that there should be more space for their sedentary and outdoor activities. If possible, they would like to spend the day time outdoors instead of watching TV at home.

At the same time aged people were asked about their state of fatigue when they go out in the yard for outdoor activities. Due to personal preferences of walkable distance for different elderly people, the existing residential area has no reasonable spaces for rest according to the interview

responses because they are concerned with the distance of how far or how long they can manage before they may fatigue. Similarly, if they go out for purposeful activities (chatting, and playing chess etc.) as shown in *Figures 6* and *7*, usually they will have to bring their own small stool as they can't stay long in a standing position.



Figure 6. The residents need to prepare small chairs to go out for a rest



Figure 7. The residents play chess at the curbside

4.3 Social Communication Needs

Whether low-rent housing settlements or ordinary residential areas, the social communication demand of human activities is essential. In the study area, the proportion of elderly people is higher than in ordinary residential communities. The outdoor environment can be the most important communication place for the elderly population since normally they will not travel long distance and the elderly would not like to be segregated from the community. However, every interior space of low-rent housing is limited, thus it is a limitation of the residents' indoor communication ability. For communication, there should be a strong sense of encouraging and strengthening communication behavior in the planning and design work.

In addition, the need of visiting spaces for adults who are the working population cannot be ignored, they are important members of low-rent housing families. They visit for talks with colleagues, friends and neighbors. For less than fifty square meters of low-rent residential interior space, receiving a visitor in the home is very tight and the residents would like to have some conversation place outdoor as shown in *Figures 8* and *9*.



Figure 8. There is no space to meet residents' strong demand of communication



Figure 9. There is no space to meet residents' strong demand of communication

5. REVIEWING PLANNING REGULATIONS FOR IMPROVEMENT OF HOUSING SPACE INSUFFICIENCY

After analysing the current condition of the study area, we attempt to figure out how to solve the problems which are brought up by the indoor space insufficiency in the low-rent housing environment. In the case study area, the total area of low-rent housing is 100,000 square meters with 2222 households; the total area of interior space of each household is less than 50 square meters with two types of housing models. Moreover, the floor area ratio is set as 3.0; greening space rate is 30% and bicycle usage is set at three bicycles for each household. This study area is subject to a high-rise residential building, tied in part with commercial facilities and public facilities. According to the housing conditions, we employed an evaluation standard, namely *Chinese Green Construction Standard*, GB/T 50378-2006. We employed six aspects of the standard to review the current situation of this area, which are: *Land-saving and outdoor environment*, *Energy saving and energy utilization*, *Water saving and water resource utilization*, *Material Saving and resource utilization*, *Indoor environment quality and Operation management*.

Some of the six contents of the standard are not related to the topic of this paper, we partly selected the relevant options from all the related standards. A preliminary assessment table, shown as *Table 2* and *3*, in which the standard of regulations are for the indoor and outdoor indicators, is applicable for reviewing if the current housing situation qualifies meeting the standards. A preliminary judgment towards the Standard was made: the initial determination of qualification is marked as a tick “√”; the unqualified options are marked as "X"; the Standard provisions temporarily unable to be judged are marked as "-". All the evaluations shown in the two tables were summarized from the discussion on the related standard provisions in a meeting between six experts of Nankai University in Tianjin after the field survey explained in this section.

Table 2. Land-Saving and outdoor environment

Standard Provisions	Result
4.1.1 Site construction does not destroy local cultural relics, natural drainage, wetland, basic farmland, forest and other reserves.	√
4.1.4 Residential building layout ensuring indoor and outdoor sunshine environment, daylight and ventilated requirements, meet the national standard "urban residential district planning and design specification of GB 50180 in the residential building sunshine standard requirements.	√
4.1.6 The rate of the residential area not less than 30%, per capita public green area of not less than 1m ²	√
4.1.9 Residential public service facilities according to plan, reasonable use of comprehensive building and sharing and its surrounding areas.	√
4.1.11 Residential environmental noise conforming to the national standard "urban regional environmental noise standard of GB 3096 regulations.	—
4.1.12 Residential outdoor daily average heat island intensity is not higher than 1.5 °C.	√
4.1.13 Residential wind environment conducive to winter outdoor walking is comfortable and transitions different seasons, for example, natural ventilation in summer.	√
4.1.14 According to the local climate conditions and plant natural distribution characteristics, planting a variety of types of plants, constructed by combining multi-level planting, every 100m ² of green space has not less than three planted trees.	√
4.1.15 Location and residential gateway setting is convenient for residents to make full use of public transport networks. Residential gateway to public	√

transportation sites walking distance is less than 500m.

4.1.16 Residential non-road motor vehicles, the ground parking lot and other hard floors using permeable ground, and the landscapes provision of shade. ✓
Outdoor permeable surface area ratio is not less than 45%.

Table 3. Indoor environment quality

Standard Provisions	Result
4.5.1 Each house has at least one living space to meet the requirements of sufficient sunlight. When there are four or more living spaces, there are at least two living spaces that meet the requirements of sufficient sunlight.	✓
4.5.2 Bedroom, living room (hall), study, kitchen set up with windows, the daylighting of the room coefficient is not lower than the national standard "architectural lighting design standard" of GB 50033 regulations.	✓
4.5.4 Living space has natural ventilation, ventilation openings in hot summer and warm winter areas. Hot summer and cold winter area is not less than 8% of the area of the room floor, in other areas is not less than 5%.	✓
4.5.5 Indoor area is free of formaldehyde, benzene, ammonia, radon and TVOC and air pollutant concentrations according to the national standard "civil building indoor environment pollution control norm" GB 50325 regulations.	—
4.5.10 By the adjustable outer shading device, there is prevention of summer sun radiation through window glass directly into the indoor space.	—
4.5.12 Bedroom and living room (hall) use materials with energy storage, humidity or improve indoor air quality functions. (design stage, this not eligible)	—

After reviewing the standard, we have a clear understanding that there are provisions issued for indoor and outdoor spaces, however, although the standard provisions are not related directly to the housing space insufficiency, it is possible for designers to consider how to use the outdoor space to compensate for indoor space insufficiency. In the next section, we will try to find a solution to the design and planning in the study area that fits the requirement of the necessary facilities in outdoor space, and to a maximum extent, that shares the functions of indoor space.

6. SUGGESTIONS AS DESIGN GUIDELINE FOR HOUSING SPACE INSUFFICIENCY

In this section we attempt to solve the main problems of housing space insufficiency of the low-rent housing in this case study area. For considering how to use public space for activity needs and social communication needs, instead of housing space, this was clarified in Section 4. Some of the design guidelines related to indoor and outdoor environments are suggested as follows according to the suggestions from experts in Nankai University.

6.1 Interlaced Functional Outdoor Space according to the Guidelines

Based on the discussion in the last section, low-rent housing, with the majority group of the elderly and disabled, should provide sufficient sitting space and activity space for incontinent people, to meet their demands of quality of living and communication.

For the elderly population, there should not be long distances designed as

green belts because they are non-sitting spaces. It is important to design the space for old people to rest and avoid large areas of green planting because of high maintenance. These thoughts about indoor and outdoor use have been put into the design principle as shown in *Figure 10*.

Besides the elderly people, although child activity facilities differ from those of the elderly population, the safety precautions of the activity space are similar. Thus, it is possible to combine the activity/sitting space of the elderly population and children, scattered as different zonings in the area.

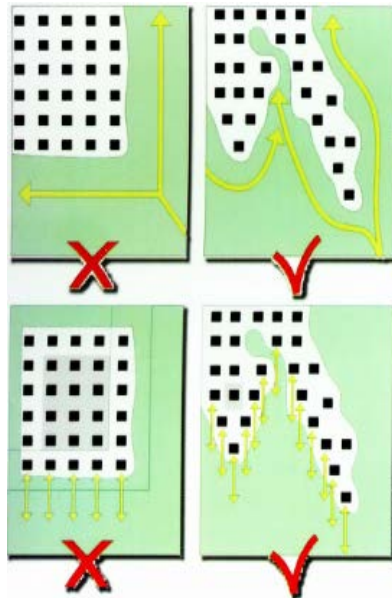


Figure 10. The interlaced pattern of functional outdoor space



Figure 11. An example of interlaced functional outdoor space

6.2 The Establishment of the “Private” Yard according to the Guidelines

In order to make up for the space deficiency of sitting space indoors, some half-closed private space is necessarily established in the residential district, which is equivalent to transferring the indoor function to a courtyard space for receiving visitors as shown in *Figure 12*.

The spatial arrangement of the private yard facilitates entry to each residential area for convenience, consisting of several half-closed places for conversation and discussion. It avoids the main road, preventing traffic interference. In the space division, trees and shrubs are the soft isolation belt, which are 0.8m to 1.3m in height, in order to provide conversation space privacy. In this way the sitting room function is moved to the outdoor environment, allowing individual communication to happen in an outdoor

environment and promoting neighborhood relationships. At the same time, the space also scatters space, achieving a variety of functions for old peoples' rest.



Figure 12. The example of the “private” yard

In order to provide a comprehensive consideration of the public space for housing space insufficiency, first, full use of the first floor space of the building must be made, combining with the landscape design and public services. Second, the needs of different age classes should be taken into consideration carefully in landscape design. Third, the open space of public activities should be combined with relatively independent groups, such as: the children’s activity space and fitness equipment playgrounds. Finally, to differ from commercial residential design, the design concept should aim for low maintenance. Besides that, it is important to increase community-supported commercial facilities for improving the use of public space in the central community area for solving the problem of housing space insufficiency.

From reviewing the residential environment and related design standards that are the Chinese Green Construction Standards from a view of housing space insufficiency, it is possible to add related new guidelines to the standard provisions for using public space to solve the problem of housing space insufficiency.

7. CONCLUSION

The contribution of this research is to explore an alternative to solve the indoor space insufficiency of low-rent housing development. This research may help the housing department of the government consider which elements of the public space may have a higher facilitation of indoor residential activities for solving the problem of housing space insufficiency.

Instead of redesigning the building, this work addresses the point that by reorganizing the residential environment to shift some insufficient indoor functions to the outdoor space, an improvement for low-rent housing can be achieved. This is easier to implement than rebuilding the whole area for residential improvement. From the result of this research, some provisions for considering public space as solutions to housing space insufficiency could be taken into consideration in low-rent housing development. In the future we will try to explore other alternatives within acceptable financial budgets in order to help low-income groups own sustainable housing environments.

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