Liveability of High-rise Housing Estates: A Resident-centered High-Rise Residential Environment Evaluation in Tianjin, China

Liveability of High-rise Housing Estates in the Context of Tianjin, China

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1. Introduction

Global climate change, energy crisis and deterioration of ecological environment are some of the most significant challenges facing humanity in the 21st century. In this context, more and more people accept the concept of sustainable development, ever since this definition, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, was presented in the Brundtland Report (WCED, 1987). City, as the main platform of human activities where almost half the energy is consumed, its sustainable development has been one of the research focuses. Various sustainable urban theories, such as Smart Growth, Compact City, New Urbanism, and Infill Development, have been advocated, and one of the common strategies adopted by these theories is to increase intensity and density of urban development. High-rise housing, as the most compact housing form, has been re-accepted as a sustainable housing solution by many policy-makers, developers, planners, and designers worldwide, after the rejection in mid-1970s (Yeh and Yuen, 2011, Turkington et al., 2004). Many stakeholders of housing system believe that high-rise housing, compared to other residential types, is a more sustainable housing form and has some advantages of sustainability, such as less land consumption (Rudlin and Falk, 1999, Jenkins et al., 2007), higher energy efficiency (Travers, 2001, Lau et al., 2005), lower resource consumption (Barter, 2000, KAJI, 2001), better accessibility to services and facilities (Jenks et al., 1996, Kaido, 2005), and can bring some positive benefits such as spectacular view, privacy and quietness (Conway and Adams, 1977, Yuen et al., 2006). In this context, mass high-rise housing developments have been or are being constructed in many cities both in developed countries and developing countries, and high-rise housing is now recognised as a global phenomenon (Yeh and Yuen, 2011).

China, as the largest developing country, has become the largest construction site in the world, where numerous high-rise housing estates have been and are being built on the ruins of original urban neighbourhoods. By the end of 2011, China's urbanization rate has surpassed 50% for the first time and reached 51.27%, which has been described as a 'historical change in the country's social structure' in Premier Wen Jiabao's Government Work Report (2012). According to the data of National Bureau of Statistics of the People’s Republic of China, urban population has rapid increased from 297 million in 1990 to 691 million in 2011. Although the rapid urbanization provides a huge impetus into the development of the economy, but such excessive urbanization brings a set of challenges, such as environmental pollution, lack of infrastructure, traffic congestion, and the huge shortage of urban housing is one of the most urgent problems. History is always a striking similarity. In spite of its own characteristics and context, China has chosen the way that many countries have selected in 1960s, to solve the housing shortage through the construction of mass High-rise Housing Estates (HHEs).

However, it is undeniable that high-rise housing is still a controversial housing form, and one of the focuses of debates is its liveability issues, such as the lack of safety and security (Newman, 1976, Wong, 2011), the destruction of social relations (Ginsberg and Churchman, 1985, Williamson, 1978), and children’s health and behavior problems (Jephcott, 1971, Young, 1976), etc. Many scholars believed that the liveability problems were one of the

reasons behind the decline of HHEs in developed countries in mid-1970s (Power, 1997, Turkington et al., 2004). But it is noteworthy that many studies on liveability issues of high-rise housing have reached contradictory conclusions. An obvious example is the significant difference of residents' satisfaction and acceptance to high-rise public housing between in the UK and in Singapore. More than 80% of Singapore's resident population are living in high-rise public housing estates and expressed high level of satisfaction, while the residents living in high-rise social housing in Glasgow voiced their dissatisfaction with the high-rise residential environment (see: GoWell, 2011, Yuen et al., 2006),This phenomenon makes more and more researchers recognize that liveability research focuses on the local people's immediately needs and practical experiences in their existing residential environments, and emphasizes the significance and specificity of local context, which substantially mediates the outcomes of high-rise living in specific loci (Gifford, 2007). Therefore, the understanding of liveability of high-rise housing must be based on their specific context, and the development of liveability theory need to combine the results of numerous studies in various contexts. Nevertheless, according to the current literature, the liveability research of high-rise housing in China is obviously deficient, which is highly disproportionate to the importance and prevalence of high-rise housing development in Chinese cities in the past decade of housing reform and rapid urbanization since 1998. Moreover, in 2011, the central government of China developed an ambitious plan to construct 36 million affordable housing in the following five years, and have invested 1,300 Billion RMB to build 10 million in 2011 (NDRC, 2011), which will further promote the development of high-rise housing. The current and coming boom of high-rise housing make the study on the liveability of the existing high-rise housing in China become very urgent and significance not only for filling the theoretical gaps but also satisfying the practical need. More importantly, during the process of high-rise housing development, residents' opinions and experiences on high-rise living have not been fully understood and considered due to the lack of public participation. Under this background, this study focuses on an inquiry into the liveability of high-rise housing through investigating residents' evaluation of the existing HHEs in the inner city of Tianjin, China.

2. Conceptual Framework

As Guido Francescato, et al (1987) pointed out, housing, in nature, should be a dynamic system which is composed of a set of components, not only including the residential environment containing physical environment and social environment, but also including the stakeholders such as residents, planners, architects, developers, the social and political organizations. According to the systems approach of Churchman (1968), the system objectives and performance measures should be determined by the 'customers' of the system, that is, who are to be served by the system. Specific to the housing system, it is no doubt that residents are the core customers of the system. Therefore, the evaluation of the housing system performance should take full account of the evaluations of residents. Meanwhile, many studies indicated that residents' satisfaction could determine housing adjustment and mobility behavior, and directly influence the development of housing system, which forms the basis for public participation (Adriaanse, 2007, Amerigo and Aragones, 1997). The historical lessons, especially the decline of HHEs worldwide in mid-1970s and the success of public high-rise housing in Hong Kong and Singapore since 1980s, show that the residents' acceptance and satisfaction with the high-rise residential environment was the fundamental and significant key to achieve the sustainable development of high-rise housing (Yeh and Yuen, 2011, Turkington et al., 2004). Based on the above notions, this study constructs a resident-centered conceptual framework in order to study the liveability of HHEs.

2.1 Liveability: a Resident-centered Residential Environment Evaluation

Liveability is an important definition to evaluate environment based on the local people's immediate needs and experiences of environment from the subjective and micro perspective (BrookLyndhurst, 2004). In the UK, for example, the Department for Communities and Local Government (O'Brien et al., 2006) defined that liveability "is concerned with the quality of space and the built environment. It is about how easy a place is to use and how safe it feels. It is about creating – and maintaining – a sense of place by creating an environment that is both inviting and enjoyable." In another research in USA, 'liveability' was defined as a wide array of issues on "satisfying human need in an urban, communal and environmentally sound context" (Shaw et al., 2004). However, many researchers have reported liveability as a concept that is difficult to define and measure (see, Wheeler, 2001, Balsas, 2004, Heylen, 2006). According to the literature review on residential environmental liveability, none of a widely accepted theory and model has been constructed until now (Whelan, 2012, Leby and Hashim, 2010, Howley, 2010). Therefore, in this study, a conceptual model of the residential environmental liveability is established (Figure 1).

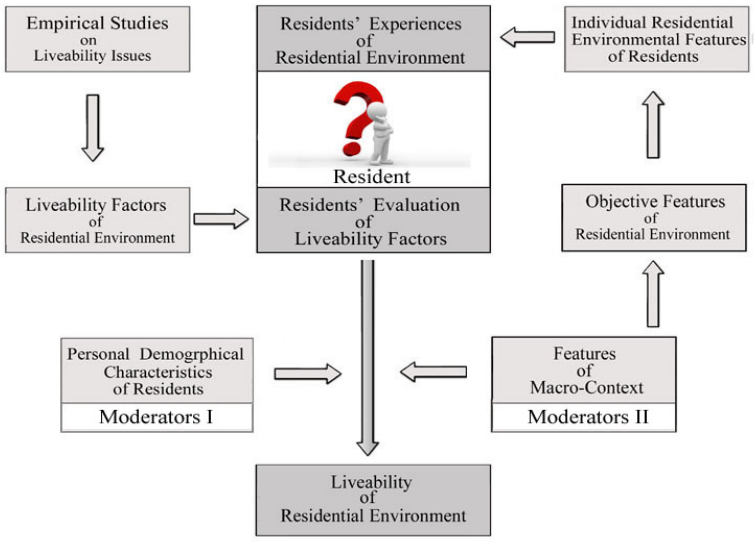


Figure 1: Resident-centered Liveability Model of Residential Environment

Liveability of residential environment is defined as a resident-centered evaluation that is based on the statistics analysis of the numerous individual's subjective evaluation of the residential environment and its liveability factors according to their perceptions and experiences of the residential environment. Residential satisfaction is widely used as the measurement of the subjective evaluation of residential environment (Amerigo and Aragones, 1997, Liu, 1999). Residential satisfaction is not only influenced by the objective features of the residential environment, but also influenced by some factors, called moderators, which are independent of the residential environment per se and may moderate the residents' experiences and evaluations. These moderators are '*factors or variables that are associated with differences in outcomes, and not in directly causal sense, but are part of a causal link between the environment and the outcomes*' (Evans and Lepore, 1997). The existing studies on residential satisfaction discovered that there were two groups of moderators: personal demographical characteristics of residents and features of macro-context (Amerigo and Aragones, 1997, Adriaanse, 2007). It has been proved by many studies that the demographical factors, such as gender, life-stage, and income level, can mediate the residents' evaluations on high-rise housing. But the features of macro-context, such as climate, housing system, and diversity of housing types, have not been fully demonstrated.

2.2 High-rise Housing Estate: a Multi-dimension Residential Environment

According to the definition of Power (1997,p.20) and Turkington, etc. (2004,p3), HHE is an distinct and discrete geographic housing area which is integrated planned, designed and constructed, and is dominated by a number of high-rise residential buildings that are multi-family housing and equip elevators due to be over the maximum height which people are willing to walk up. However, from the perspective of residents, on the one hand, HHE not only includes the physical environment where the residents are living in, but also includes the psychological and social environment which satisfies the resident's non-material needs, such as safety, comfort, and social interaction. On the other hand, HHE constructs a multi-level residential environment that includes: the private family spaces, the collective residential building of shared ownership, the semi-public gated community, and the public urban neighbourhood. Therefore, in this study, HHE is defined as a resident-centered and multi-dimension residential environment that is composed of the psycho-social environment and the physical environment, where the resident is placed at the center of a series of spatial dimensions, which starts with the 'Dwelling Unit' and enlarges, layer by layer, from 'Dwelling Building', 'Housing Estate', to 'Urban Neighbourhood' (Figure 2).

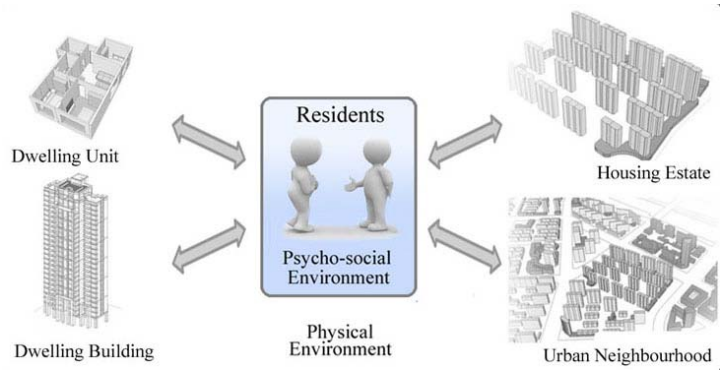


Figure 2: Resident-centered Residential Environment of HHE

3. Research Design

3.1 Research Questions

As Herbert Gans (Gans, 1968) indicated that there is a gap between 'potential environments' proposed by designers, developers and policy-makers, and 'effective environments' participated in by the users, which inevitably resulted in some incompatibility between the built environment and users. Specific to HHEs, mass standardized and profit-oriented planning and design resulted in the deterioration of residential environment, such as overcrowding, noise and air pollution, heat island effect, etc. Therefore, it is necessary to understand residents' experiences and perceptions of the existing high-rise residential environment, not only for the diagnosis of the current problems, but also for the improvement of the future planning and design. The purpose of this study is to seek answers to the following three questions:

1. From the perspective of resident, what is the relationship between overall residential environment of HHEs and its four sub-dimensions: dwelling unit, dwelling building, housing estate and urban neighbourhood? What are the residents' liveability evaluations of residential environment and its four sub-dimensions in the context of Tianjin, China?
2. What are the liveability evaluations of different typologies of high-rise residential environments? How do the features of residential environment impact on residents' evaluations? How do the demographic characteristics of residents impact on their evaluations in the context of Tianjin, China?

3. How can the planning and design of HHEs be improved to increase the liveability? How are the policies and regulations of urban housing development adjusted to guide and control the development of HHEs in order to improve the liveability of residential environment in the context of Tianjin, China?

3.2 Research Strategy: an Embodied Multiple-case Study

Robert Yin (1994) defined that 'a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context.' Many studies on high-rise housing prove the validity of the research strategy, such as Newman's work (1976) on defensible space, and Abel's work (2003) on high-rise building design. This study focuses on the liveability of high-rise residential environment in the context of Tianjin, China. According to Groat and Wang (2002), in a narrow research scope, if important factors vary from one case to another, the multiple-case study will be more advantageous than single-case study. For the residential environment of HHEs, the high-rise building form is the most significant difference with other housing types. During the rapid urban renewal of the inner city of Tianjin, there are three high-rise housing forms: ***slab high-rise housing***, ***short-slab high-rise housing*** and ***tower high-rise housing***. According to Tianjin's codes and regulations of high-rise housing planning and design, the criteria of insolation interval of slab high-rise building are higher than that of short-slab and tower (slab high-rise: the height of building multiplied by the insolation coefficient of slab high-rise; short-slab and tower: the width of building multiplied by the insolation coefficient of tower). Generally speaking, tower HHEs have highest development intensity and population density due to the small insolation interval, while slab HHEs have the greatest insolation interval among the three high-rise forms. In the climate condition of Tianjin (hot summer and cold winter), slab HHEs usually have better natural ventilation and lighting than tower, which result in the tower having lower market acceptance. Due to the combination of advantages of slab high-rise and tower, the short-slab high-rise has become the most popular building form. The various combinations of the three high-rise housing forms produced the four different typologies of HHEs: ***dominated by slab high-rises***, ***mixed slab and short-slab high-rises***, ***dominated by short-slab high-rises***, and ***mixed short-slab high-rises and towers***. The four typologies of HHEs provide the basis of multiple-case study. As for the number and the standard to choose cases, Yin (1994) indicated 'every case should serve a specific purpose within the overall scope of inquiry.' The rationality of development of HHEs is based on the conflict between the increasing housing demand and the limited land (Rudlin and Falk, 1999). And the history of HHEs indicated that the development of HHEs in low density suburb was not a sustainable way (Turkington et al., 2004). Therefore, the author focused on the liveability of HHEs that were developed in high-density inner city. Moreover, the study employs the residents' satisfaction to measure the liveability of high-rise residential environment, which can be influenced by the local surrounding environment of research cases. Amérigo and Aragonés (1990) indicated that the distinct geographical placement of the samples could directly moderate the evaluations. Therefore, the selection of research cases should control over the key or independent variables, which can make the research much closer to the ideal situation (Gifford, 2002). In summary, there are existing two basic requirements: 1, each typology of HHEs should have the relevant case; 2, the research cases should be located in one urban district in order to minimize the impact of the different external contextual factors. For the above reasons, an embodied multiple-case study was chosen as the research strategy.

Tianjin is one of the four largest municipalities in China, and its urban regeneration started from 2003. The large-scale inner-city redevelopments and prosperous property development, as well as the rapid increase of property and land price boosted the massive developments of HHEs and the rapid evolution of the typologies. The four research cases, represented four typologies of HHEs, are choose in the north part of NanKai District where one of the most important redevelopment projects, Tianjin Old Town Regeneration, was located in (Figure 3).

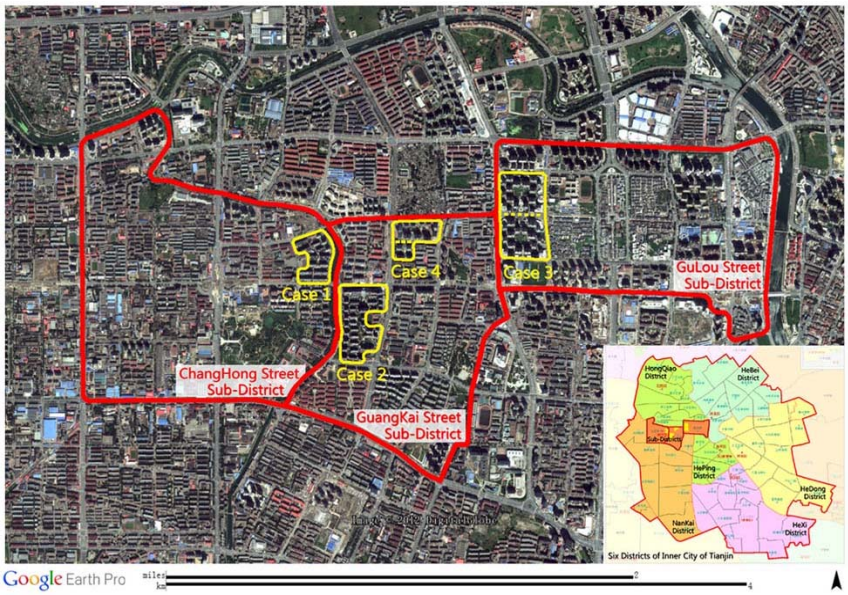


Figure 3 Geographical location and administrative attribution of the four research cases
Source: compiled from compiled from the maps on Google Earth (2011) and Tianjin City Master Plan (2005-2020)

3.3 Data Collection: Documentary Analysis and a Two-step Survey in Four Cases

In this study, data collection consists of the following three parts. Firstly, a documentary analysis was carried out to summarized the liveability factors of high-rise residential environment through reviewing the literatures on liveability issues of high-rise housing in various contexts; and then, by means of planning and design documentary analysis and site survey, the objective features of the four research cases, representing the four typologies of HHEs, can be revealed (Table 1); finally, a two-step survey was carried out in the selected cases to obtain the data on residents' satisfaction with residential environment and its liveability factors, while the information on respondents' personal demographical characteristics and individual residential environmental features was collected.

Residential Environment of HHE						
Dwelling Unit		**Dwelling Building**		**Housing Estate**		**Urban Neighbourhood**
Size	1 Bedroom DUs	Building form	Slab high-rise	Dominated by Slab HHE (Case 1)	12 Slab high-rises (9-13-storey) 3 Short-slab high-rise (18-storey)	Mature urban neighbourhood
	2 Bedroom DUs		Short-slab high-rise			
	3 bedroom DUs		Tower high-rise			
Storey	1-5	House-hold density	2 DUs per floor	Mixed slab and short-slab HHE (Case 2)	16 Slab high-rises (9 & 28-storey) 17 Short-slab high-rises (18, 28-storey)	Mature urban neighbourhood
	6-10		3 DUs per floor			
	11-20		4 DUs per floor			
	Over 21		6 DUs per floor			
Orienta-tion and Layout	South-North with cross-ventilated	Location of DB in HHEs	Near the Boundary of HHEs	Dominated by short-slab HHE (Case 3)	35 Short-slab high-rises (27 & 28-storey)	Recently completed brand new urban neighbourhood
	South without cross-ventilated					
	South corner location of tower high-rise		Near the Middle of HHEs	Mixed short-slab and tower HHE (Case 4)	13 Short-slab high-rises (18 & 26-storey) 2 Tower high-rises (32-storey)	Partly renewal urban neighbourhood
	Other corner location of tower high-rise					

Table 1 Residential Environmental Features of HHE

The liveability survey consists of two stages: the first stage is a combination of questionnaire and preliminarily interviews with respondents at random sampling and an out-door observation from the three environmental scales: Dwelling Building, Housing Estates and Urban Neighbourhood; the second stage is an in-depth interview with voluntary respondents and the in-door investigation of their Dwelling Units. In the first stage, five investigators carried out face-to-face verbal questionnaire survey of the randomly selected respondents, and simultaneously had the preliminarily interview with the voluntary respondents using structured interview based on the questionnaire. In the Stage I survey, the author and four assistants collected 214 questionnaires and conducted 55 preliminary interviews. In order to increase the diversification of the respondents, two site investigations were carried out respectively on a weekend and on a weekday in each study case. Among the 214 respondents, there were 14 who were willing to participate in the in-depth interview. In the second stage, the author was invited into the homes of the 14 respondents to conduct semi-structured interviews and in-door investigations of their dwelling units. The detailed information on this survey is shown in Table 2.

Target Cases for Investigation	Quantity of Sample	Quantity of Dwelling Units	Sample Rate (%)	Quantity of Preliminarily Interview	Quantity of In-depth Interview
Case 1:ShengDa Garden	49	1276	3.8	15	3
Case 2: Style of Spring	51	1775	2.9	16	4
Case 3: FuLi Town	57	3457	1.6	14	3
Case 4:BaoLong Bay	57	1314	4.3	10	4

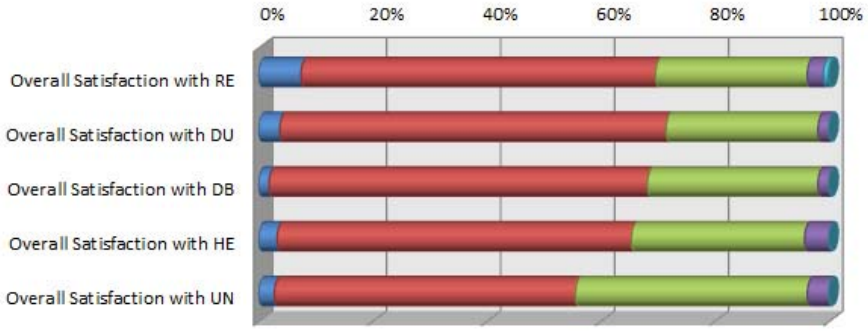
Table 2 Timetable and overall information of the liveability survey

The questionnaire consists of three parts: the respondent's personal demographical information, individual residential environmental features, and his/her satisfaction with their residential environment. The last part is a three-level hierarchy structure: firstly, the respondent was asked to rate his/her satisfaction on each of the 56 livability factors on a 5-point scale, with 1 denoting 'very dissatisfied', and 5 denoting 'very satisfied'. The liveability factors were arranged according to the four spatial dimensions: Dwelling Unit, Dwelling Building, Housing Estate and Urban Neighbourhood; Secondly, the respondent was also asked to respectively give an overall evaluation on the four dimensions; finally, the respondent was asked to decide the level of satisfaction on the overall Residential Environment covering the four dimensions. This paper focuses on the analysis of the relationships between the last two levels: the four spatial dimensions and the overall residential environment. The in-depth analysis of the liveability factors will be reported in future research papers.

4. Results and Findings

As mentioned above, based on the features of HHEs, the questionnaire surveyed the residents' satisfaction with the overall Residential Environment (RE) and its four sub-dimensions: Dwelling Unit (DU), Dwelling Building (DB), Housing Estate (HE) and Urban Neighbourhood (UN). In this hierarchical structure, the mean of overall satisfaction by all respondents with RE is 3.715 on a 5-point scale; the mean values of satisfaction with DU, DB, HE, and UN are 3.734, 3.682, 3.645 and 3.547, respectively (Figure 4). The ranking of the level of satisfaction on the four sub-dimensions shows that, as the spatial level enlarges from DU, through DB and HE, to UN, the satisfaction level as rated by the occupant declines. Analysis of variance (ANOVA) is carried out on the occupants' assessments of DU, DB, HE, and UN to test the significance of the differences, and the result indicates that there are no significant differences among the evaluations of DU, DB and HE, but there is a significant difference between them and the evaluation of UN. In other words, the residents are more

satisfied with the immediate environment of their homes, buildings and estates than the external urban neighbourhood, within which their housing estates situate in.



	Overall Satisfaction with RE	Overall Satisfaction with DU	Overall Satisfaction with DB	Overall Satisfaction with HE	Overall Satisfaction with UN
Very Satisfied	6.50	3.74	1.87	3.27	2.80
Fairly Satisfied	63.10	67.76	66.36	62.15	52.80
Neither, Nor .	26.60	26.64	29.91	30.37	40.65
Fairly Dissatisfied	2.80	1.87	1.87	4.21	3.74
Very Dissatisfied	0.93	0.00	0.00	0.00	0.00
Mean	3.715	3.734	3.682	3.645	3.547

Figure 4 Distribution of overall satisfactions with RE and its four sub-dimensions (DU, DB, HE, & UN)

Next, ANOVA is carried out to examine the differences of satisfaction levels with RE and the four sub-dimensions among the groups with different objective features of residential environment. As shown in table 1, the objective features have been summarized in 8 groups of variables on the four sub-dimensions. On the dimension of DU, there are three groups of variables to be tested: size, orientation and layout, and storey. The result of ANOVA indicates that there is no difference of the overall satisfactions between the residents who are living in one-bedroom DUs and those living in two-bedroom DUs, but there is a significant difference between them and the residents living in three-bedroom DUs. Among the 214 samples, 58.9% are living in two-bedroom DUs. Through analysis of covariance (ANCOVA), it was discovered that the location of DB in HHEs has significant correlation with size of DU. Data shows that 65.1% of two-bedroom DUs are located near the boundary of HHEs comparing to 31.0 % of three bed-room DUs. Similarly, between the groups of residents who are living in the DUs of south-north orientation and cross-ventilated layout and those living in the DUs of south orientation without cross-ventilation, there is no significant difference of evaluations, while their means are significantly higher than the means of satisfaction of residents who's DUs are located in south corner and other corners of tower high-rise. ANCOVA indicates that the orientation and layout of DU have significant correlation with the high-rise building form and household density of DB. Among the respondents who are living in different floors, there is no significant difference of overall satisfactions with RE and the four sub-dimensions.

On the dimension of DB, the high-rise housing form: slab, short-slab and tower, have very directly influence on the overall satisfactions (Table 3). The result of ANOVA indicates that the satisfactions of slab high-rise were significantly higher than short-slab high-rise at the 0.05 level, and the satisfactions of both slab and short-slab were significantly higher than tower at the 0.01 level. Data analysis is consistent with the reality that the slab and short-slab high-rise is benefited from lower household density within building, better natural lighting and ventilation to have better liveability. The groups of residents who are living near boundary of HHEs and middle of HHEs, have very significantly different evaluations of RE and the four dimensions at the 0.01 level. The residents living in central area of HHEs are more satisfied

with RE and the four dimensions than those living near boundary of HHEs (Table 4), which reveals the negative impact of the external UN on the liveability of RE in the context of Tianjin.

Three High-rise Building Forms		Overall Satisfaction with RE	Overall Satisfaction with DU	Overall Satisfaction with DB	Overall Satisfaction with HE	Overall Satisfaction with UN
High-rise slab building	Mean	**3.938**	**3.951**	**3.852**	**3.840**	**3.802**
	N	81	81	81	81	81
	S.D.	.429	.384	.422	.535	.485
High-rise short-slab building	Mean	**3.624**	**3.632**	**3.615**	**3.556**	**3.419**
	N	117	117	117	117	117
	S.D.	.740	.610	.585	.636	.646
High-rise tower Building	Mean	**3.250**	**3.375**	**3.313**	**3.313**	**3.188**
	N	16	16	16	16	16
	S.D.	.775	.500	.479	.602	.544

Table 3 Means of Satisfactions of Three High-rise Housing Forms

Location of DB in HHEs		Overall Satisfaction with RE	Overall Satisfaction with DU	Overall Satisfaction with DB	Overall Satisfaction with HE	Overall Satisfaction with UN
Near Boundary of HHEs	Mean	**3.582**	**3.615**	**3.557**	**3.549**	**3.434**
	N	122	122	122	122	122
	S.D.	.737	.581	.590	.669	.589
Middle of HHEs	Mean	**3.891**	**3.891**	**3.848**	**3.772**	**3.696**
	N	92	92	92	92	92
	S.D.	.523	.479	.418	.516	.624

Table 4 Means of Satisfactions of Two Types of Location of DB in HHEs

On the dimension of HE, among the four typologies of HHEs, the satisfactions with the case four that consists of short-slab and tower high-rises and is located in partly renewal urban neighbourhood, is significantly lower than the other three ones (Table 5). ANCOVA indicated that the building form, as the main covariate, impact the residents' satisfactions with RE and the four dimensions. On the dimension of UN, the case four is located in a partly renewal urban neighbourhood, and there is a low-quality old block on its north side, which obviously deteriorate the external neighbourhood environment. Although the case three was located in a brand new neighbourhood which has just completed, the satisfaction level is significant lower than that of mature neighbourhood of case one and case two.

Four Typologies of HHEs		Overall Satisfaction with RE	Overall Satisfaction with DU	Overall Satisfaction with DB	Overall Satisfaction with HE	Overall Satisfaction with UN
Dominated by Slab High-rises (Case 1)	Mean	**3.959**	**3.918**	**3.857**	**3.796**	**3.776**
	N	49	49	49	49	49
	S.D.	.498	.449	.456	.499	.511
Mixed Slab and Short-slab High-rises (Case 2)	Mean	**3.941**	**3.961**	**3.902**	**3.882**	**3.824**
	N	51	51	51	51	51
	S.D.	.420	.344	.361	.516	.518
Dominated by Short-slab High-rises (Case 3)	Mean	**3.912**	**3.825**	**3.772**	**3.737**	**3.579**
	N	57	57	57	57	57
	S.D.	.635	.468	.501	.583	.565
Mixed Short-slab and Tower High-rises (Case 4)	Mean	**3.140**	**3.281**	**3.246**	**3.211**	**3.070**
	N	57	57	57	57	57
	S.D.	.718	.620	.544	.619	.563

Table 5 Means of Satisfaction with Four Typologies of HHEs

Further, the difference of satisfactions among various demographical groups is tested to explore the impact of these moderators. ANOVA clearly states that gender, age, size of household, and level of education of the respondents has no significant impact on the satisfactions. The residents of high family income (over 5000 Yuan per month) are significantly more satisfied with RE and the four sub-dimensions than those of low income. And there is a trend that the satisfactions increase with the rise of family income. From the perspective of the life-stage of the respondents, the elderly (couple) living alone have lower satisfactions with their high-rise flats, but those with children living together have higher satisfaction. The young couples with younger children have no difference with other groups, which is inconsistent with the conclusions of many empirical studies in the western context. Other factors, such as type of tenure, length of residency, and whether to have ever lived in high-rise, have no significant effect on the evaluations.

Finally, a correlation analysis and linear regression analysis respectively are carried out to examine the relationships between RE and the four sub-dimensions. The correlation analysis indicates that there are very significant correlations between them, which meet the conditions to carry out a multiple regression analysis. Moreover, sample size (N=214) meet the condition that each predictor should have 10 or 15 samples (Field, 2005). And then, the overall satisfaction with RE as dependent variable, the satisfactions with the four dimensions as independent variables, the standard regression equation can be generated:

RE = 0.420*DU + 0.061*DB + 0.084*HE + 0.149*UN (Table 6)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.600	.290		2.066	.040
	Overall Satisfaction with DU	.514	.093	**.420**	5.546	**.000**
	Overall Satisfaction with DB	.077	.099	**.061**	.778	**.437**
	Overall Satisfaction with HE	.092	.083	**.084**	1.115	**.266**
	Overall Satisfaction with UN	.165	.078	**.149**	2.119	**.035**
Dependent variable: Overall Satisfaction with RE; Independent variable: Overall Satisfaction with DU, Overall Satisfaction with DB, Overall Satisfaction with HE, and Overall Satisfaction with UN.						

Table 6 Linear Regression Analysis of Satisfactions with RE and Four Dimensions

The standard regression equation shows that, in the context of Tianjin, the overall satisfaction with overall RE of HHEs can be predicated from a combination of the four sub-dimensions: DU, DB, HE and UN as predicator variables multiplied by their respectively coefficients. The standardized coefficients reveal the weighting of the four dimensions for overall satisfaction with RE, which can provide a new perspective to look upon the key issues of the urban high-rise housing planning and design. It was revealed that the interior design, layout and decoration of DU are more important for the improvement of the liveability than the architecture design and planning of HHEs. The design and planning of UN has more direct impact on the liveability of RE than the DB and HE. DU is the private space and the fundamental container of daily life, and has the direct relationship with the liveability of RE; UN is the basic unit of public facilities and services such as school, public transportation and commercial facilities, and provide the important functional supports for the life of residents. On the contrary, although HE is an integrated development unit, it does not provide the relevant life support functions as does UN, therefore it has the less weighting than DU and UN. Among the four sub-dimensions, DB has the lest contribution for the overall satisfaction with RE, which may be owing to the lack of a sense of belonging caused by too many households living in one building.

5. Discussions and Conclusions

In this study, the author defined the four research cases according to the various combinations of the three high-rise housing typologies: slab, short-slab and tower high-rise. The findings of this study support the hypothesis that, in the study of HHEs, building forms are directly related with the liveability of HHEs. In the context of Tianjin, China, the building forms are categorized into a combination of slab, short-slab and tower high-rise, and it is concluded that this way of categorizing HHEs is suitable for the purpose of this study.

The profit-oriented housing development in Tianjin prompts the mass construction of short-slab and tower high-rise with higher intensity but lower liveability. However, in a long term, the lack of liveability of the HHEs is likely to result in the deterioration of urban environment and poverty concentration, and finally have to be cleared as slums in the urban regeneration process, which have occurred in the developed countries (Turkington et al., 2004). Therefore, planning and design guidance and development control of HHEs to improve the liveability is an important issue. The results of this study show that mixed slab and short-slab HHE received the highest evaluation, which means that mixed slab and short-slab HHE is a better way to balance liveability and development intensity. The mixed typology of HHE not only constructs more comfortable and multiform physical environment, but also produces more harmonious social environment by providing diversified housing choices for various social groups to achieve a greater degree of social mix.

The lower satisfaction with urban neighbourhood and the negative effect of urban neighbourhood, as shown by the lower satisfactions of the residents living near the boundaries of HHEs, indicate that the urban environment in the inner city of Tianjin need to be improved to increase the overall liveability of residents. The significant correlation of urban neighbourhood with overall residential environment further emphasizes the necessity and the importance of the improvement. On the other hand, it should be noted that high-density HHEs may be the potential reason that caused the low satisfaction of urban neighbourhood due to greater pressure on the neighbourhood environment and public facilities. Therefore, the neighbourhood environmental carrying capacity should be a key factor to control the development intensity and density of HHEs. Finally, the concentration of high-rise buildings can change the micro-climate of urban neighbourhood and urban landscape, and result in the rise of the environmental temperature (Heat island effect), the deterioration of wind environment (Wind tunnel effect), and the decline of air quality. These

negative outcomes should be fully studied in order to find the methods to improve the liveability of urban neighbourhoods.

The analysis of demographical factors demonstrated features which are different with many empirical studies conducted in other contexts. In the four research cases, the residents of HHEs are diverse in the terms of the size of household, level of family income and education, which is different with many HHEs in developed countries, where new HHEs usually focus on special groups such as the elderly, young professionals and wealthy people who like the city life. The reason for this phenomenon may be that HHEs are still in the early development stage in Tianjin (only started since 2003), and housing mobility has not beenfully developed. Meanwhile, the homogenized housing market has not provided diversified housing choices at the same prices and locations, which means that the inner-urban residents do not have many other choices besides these high-rise housing estates. It indicates that the policy-makers should promote the diversification of housing types to meet the diversified housing demands.

The standard regression equation of the satisfaction with overall residential environment and its four sub-dimensions not only revealed the residents' cognition of HHEs, but also reflected the problems in the urban management system of China. In the current system, the core of management and control is the design of dwelling building and the planning of housing estate, the former relates to the urban landscape and the latter as development unit relates to the urban function. However, the two dimensions have weaker relationships with liveability of HHEs than dwelling unit and urban neighbourhood from the perspective of residents. Especially for dwelling unit, in spite of its direct impact on liveability, there are no effective institutional structure to ensure the quality of residential interior design and decoration In terms of urban neighbourhood, the user-centered planning and management concepts have not been established. More importantly, the lack of public participation cause the system to have no means to gain the users' opinion and feedback, which resulted in the invalid and even backfired policy designs. To conclude, when liveability becomes the key issue of planning and design, we should be humble to listen to the voice of the user's.

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