Welsh School of Architecture

Cardiff University

Liveability of High-rise Housing Estates

– Case studies in the inner city of Tianjin, China

Thesis for the degree of Doctor of Philosophy

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Dedicated to my son Antu Li

Abstract

In the past ten years, China's urban population has increased rapidly. High-rise housing estates have been widely accepted as a 'sustainable' and 'effective' solution to urban housing shortage. However, high-rise housing has long been under debate with critics claiming liveability problems to be one of the reasons behind the decline of such development form in the mid-1970s. China presents a different context in the research on high-rise housing from other developed countries. This study focuses on an inquiry into the liveability of high-rise housing estates through investigating residents' experience and evaluation on current high-rise living in the context of a Chinese city.

The main contribution of this research to the existing literature is considered to be two-fold: Firstly, in the theoretical dimension, this research fills the research gap on the liveability study of high-rise housing in China, by establishing a resident-centred theoretical framework on the liveability of high-rise housing estates with a specific focus on housing planning and design in the Chinese context; Secondly, in the practical dimension, this research presents an empirical study on the liveability issues of current high-rise housing development in China, and provides implications for future planning and design of high-rise housing in high density urban areas.

This study adopts a research strategy based on an embedded multiple-case study integrated with historical analysis, qualitative and quantitative survey to dissect the liveability of four high-rise housing estates in the inner city of Tianjin, China, with each representing one typical design type. This study provides an understanding on the impact of the macro-context on the development of high-rise housing estates and residents' perception of the liveable residential environment; it explores the residential environment features and residents' actual experience of high-rise living; it acquires residents' liveability evaluation of high-rise housing estates, which not only reveals the liveability strengths and weaknesses of current high-rise housing development, but also discovers the measurement, indicators and dimensions of the liveability of high-rise housing estates, and provide implications for both theoretical research and practical development.

List of Publications

Lu Sun, Chenguang Li, Julie A. Gwilliam and Phillip J. Jones, 2013, "Sustainable Peri-urban Residential Settlement Development in China: evaluation of three cases in Tianjin", International Journal of Sustainable Development and Planning, Volume 8, Issue 4

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Chapter one

Introduction

'Whatever the desire, a changing is happening: living in (high-rise) flats may and could increasingly become an urban norm for many more people in cities in the coming decades.'

--- Anthony G. O. Yeh and Belinda Yuen (2011, p3)

1.1 Research background

Global climate change, energy crisis and deterioration of ecological environment are some of the main challenges facing humanity in the 21st century. In this context, more and more people accept the concept of sustainable development, ever since its 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). Cities, as the main platform of human activities where almost half of the total energy is consumed, have become one of the main focuses of research on sustainable development. Various sustainable urban theories, such as Compact City (Neuman 2005), New Urbanism (Leccese and McCormick 2000), and Urban Renaissance (Sorensen, Okata et al. 2010), have been advocated, and one of the common strategies adopted by these theories is to increase the 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 its declination in the mid-1970s (Turkington, Kempen et al. 2004, Yeh and Yuen 2011). Many stakeholders believe that high-rise housing, compared to other residential types, is a more sustainable housing form and has many advantages, such as less land consumption (Rudlin and Falk 1999, Jenkins, Smith et al. 2007), higher energy efficiency (Travers 2001, Lau, Wang et al. 2005), lower resource consumption (Barter 2000, KAJI 2001), better accessibility to services and facilities (Jenks, Burton et al. 1996, Kaido 2005), and can bring some positive benefits such as spectacular view, privacy and quietness (Conway and Adams 1977, Yuen, Yeh et al. 2006). Meanwhile, high-rise housing development can bring higher profit to developers, provide more dwellings to residents in attractive locations, and construct 'remarkable' urban landscapes that are one of the pursuits of governments, planners and designers (Glendinning and Muthesius 1994, Turkington, Kempen et al. 2004, Naz 2007). In this context, mass high-rise housing developments have been or are being constructed in many cities in both developed and developing countries. High-rise housing is now recognized as a global phenomenon (Yeh and Yuen 2011).

China, as the largest developing country, has become the largest construction site in the world, where large-scale high-rise housing estates 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, 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, urban population has rapidly increased from 297 million in 1990 to 691 million in 2011 (Table 1-1). Although rapid urbanization has provided a huge impetus to economy development, such excessive urbanization also brings a set of challenges, such as environmental pollution, lack of infrastructure, traffic congestion, and the huge housing shortage.

Table 1-1 Population and Urbanization Rate of China from 1990 to 2011

	1990	2000	2010	2011
Total Population	1,160,017 ,381	1,265,830,000	1,370,536,875	1,347,350,000
Urban Population	296 ,512, 111	455,940,000	665,575,306	690,790,000
Urbanization Rate	26.23%	36.09%	49.68%	51.27%

Source: compiled from the data of National Bureau of Statistics of the People 's Republic of China

History is always a striking similarity. In spite of its own characteristics and context, China chose the way many countries have selected in the 1960s: to solve the housing shortage through the construction of mass high-rise housing. On the one hand, the urgent housing demand and the reality of limited land and increasing population have made high-density development a reasonable choice; on the other hand, the research and practice on high-rise housing developments in Hong Kong and Singapore have provided theoretical backing for this choice.

However, high-rise housing is still a controversial housing form. One of the focuses of debates is on its liveability issues, such as the lack of safety and poor security (Newman 1976, Wong 2011), destruction of social relations (Williamson 1978, Ginsberg and Churchman 1985), residents' mental health problems (Cappon 1971, Hannay 1981, Freeman 1993), children's health and behavior problems (Jephcott 1971, Young 1976). Many researchers believed that the liveability problems were the main reasons for the decline of high-rise housing estates in the developed countries since the mid-1970s. A great number of empirical studies further made researchers recognize the significance of liveability in contemporary urban housing theories and practices, and some scholars even considered liveability as a necessary complement to the notion of sustainability (Godschalk 2004, PLC 2011, Whelan 2012).

Nonetheless it is noteworthy that many studies on liveability issues of high-rise housing have reached contradictory conclusions. An obvious example is the difference in residents' satisfaction and acceptance to high-rise public housing between the UK and Singapore (see: Yuen, Yeh et al. 2006, GoWell 2011). This phenomenon has led to the recognition that liveability research needs a comprehensive framework that not only focus on the local people's immediately needs and practical experiences in their existing residential environments, but also emphasize the significance and specificity of local context that substantially mediates the outcomes of high-rise living in a specific loci (Gifford 2007). Therefore, the understanding of high-rise housing liveability must be based on its specific context, and the development of liveability theory needs to combine the results of numerous studies in various contexts with understanding of local residents' actual living experiences.

Existing literature on the liveability research of high-rise housing in China is limited, which is highly disproportionate to the importance and prevalence of high-rise housing development in Chinese cities in the past decades 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 houses in the following five years. In the year 2011 alone, an amount of 1,300 Billion RMB has been invested to build 10 million affordable houses throughout the country (NDRC 2011). The current and coming boom of high-rise housing makes the study on the liveability of existing high-rise housing in China an urgent need.

1.2 Research aim, questions and objectives

Driven by commercial interests, housing shortage and urban development, numerous Chinese traditional neighbourhoods, Soviet-style walled work units and residential quarters in many cities have been intensively redeveloped into high-rise housing estates. The State ownership of land has further ensured the wide adoption and speed implementation of such regeneration programmes (Lu 2006). Consequently, in the combined effect of social, economic, historical and cultural elements, such large-scale and gated high-rise housing estates have become the dominant housing form, and have been profoundly changing urban environment and people's lifestyle (Lu 2004). As a brand new housing form in China, both professionals and residents are exploring and experiencing the high-rise residential environment with a novel vision. However, theoretical research on the liveability of high-rise housing estates in China significantly lags behind their rapid developments in practice. With few existing empirical studies to provide evidence, current norms in the planning and design of high-rise housing estates are taken blindly for granted and ways to improve the quality of high-rise living are little explored.

To fill the research gap, this study aims ***to provide an empirical study on the liveability of the existing high-rise housing estates in China in order to inform practical development of high-rise housing estates, and make theoretical contribution to the research on the liveability of high-rise housing estates.***

To achieve the aim, four lines of research questions are raised:

1. *What are the macro-contextual features of high-rise housing estates in China, and how do the contextual forces shape the high-rise residential environment and impact the residents' perception of the liveable residential environment?*

2. *What are the residential environmental features of high-rise housing estates in China, and what are the residents' liveability experiences of the high-rise residential environment?*

3. *What are the residents' liveability evaluations of the high-rise residential environment in China, and what are the strengths and weaknesses of liveability of*

high-rise housing estates from the practical perspective?

4. *What are the relationship between the residents' liveability evaluation, demographic features and residential environment features, and what are the measurement, indicators and dimensions of liveability of high-rise housing estates from the theoretical perspective?*

By achieving the main aim of this research and finding answers for the research questions, a number of objectives are derived. The main objectives of this research are as follows:

1. *To understand the development and evolution of high-rise housing estates in the context of China, and reveal the mechanisms that the macro-context shape high-rise residential environment and form resident' living habits and housing preferences;*

2. *To summarize the residential environment features of high-rise housing estates in China, investigate actual usage conditions and understand residents' liveability experience of the high-rise residential environment;*

3. *To analysis the residents' liveability evaluation of the high-rise residential environment, explore the strengths and weaknesses of liveability of the existing high-rise housing estates in China to inform the practical development;*

4. *To dissect the important theoretical issues on liveability of high-rise housing estates, find out the measurement method, establish the indicator system and summarize the dimensions to develop the liveability theory of high-rise housing.*

The main contributions of this study to the existing liveability research is considered to be two-fold: firstly, in the theoretical dimension, this research will fill the research gap by establishing a resident-centred theoretical framework of liveability of high-rise housing estates with a specific focus on housing planning and design and providing an up-to-date empirical study on the liveability of high-rise housing estates in China; Secondly, in the practical dimension, this research will also make contributions to understand the mechanisms of high-rise housing development, recognize the liveability strengths and weaknesses, and propose suggestions to improve the liveability of both the existing and future high-rise housing estates in high-density cities.

To sum up, it is intended that the conclusions and findings of this research will provide scholars with a research framework and empirical study on the liveability of high-rise housing estates, while helping policy-makers, planners, and architects to understand the residents' experience and evaluation of the existing high-rise residential environments, and make contributions to achieve sustainable development of high-rise housing estates.

1.3 Thesis structure

This thesis consists of eight chapters which can be divided into three parts. Chapters 1 to 3 constitute the first part which introduces the research background, raises the main research questions, establishes the theoretical framework, and develops a feasible methodology for the study as a whole. Chapters 4 to 7 constitute the second part which is focused on the empirical study on the liveability of four high-rise housing estates in the inner city of Tianjin, China. The final chapter constitutes the third part which reviews major research findings, synthesizes all the conclusions in response to the research questions, proposes the policy recommendations, and suggests possible directions for future research.

Chapter 2 aims to establish a theoretical framework to guide the whole research. It first defines the two fundamental concepts of liveability and high-rise housing estate, the former is the user-centred environment evaluation based on the context, and the latter is the high-density housing type consisting of multiple spatial levels. Through the brief retrospect on the evolution of high-rise housing, it explains the historical facts and lessons which are significant to the development of today's high-rise housing estates, and outlines the macro-context of the evolution of high-rise housing estates. Then it reviews the debates and empirical studies on the liveability of high-rise housing, and explores the main research gaps: 1) the lack of a resident-centred theoretical framework; and 2) the scarcity of research in the context of China. Finally, by sorting out the practices and studies of planning and design of high-rise housing estates, it summarizes the potential liveability elements and forms the liveability evaluation model.

Chapter 3 establishes the research framework and methodology. Firstly, it proposes the resident-centred research framework. Then, it builds an embedded multiple-case study as the research strategy, which integrates a historical analysis to reveal the embedded macro-context, a qualitative survey to explore residential environment features and residents' experience of the study cases, and a quantitative survey to obtain residents' liveability evaluation. Finally, it explains the research methods including document analysis and a two-stage field survey integrated with site investigation, questionnaire, and interview.

Chapter 4 focuses on the macro-context analysis of the study cases. It firstly reviews the urban development of the city of Tianjin, and reveals the macro-context features including geography, population, climate and economy. And then it discussed the large-scale urban regeneration of the inner city in the past decade, which forms a rapidly developing high-density urban environment, with high-rise housing estates becoming the dominant housing type. It went on to summarize the typologies of urban residential environments in the inner city, reviews their evolution and dissects their influence on residents' living habits and housing preferences. Finally, it identifies the four typical forms of high-rise housing estates, which provide the basis of the multiple case study in Chapters 5 and 6.

Chapter 5 is focused on the analysis of residential environment features and residents' liveability experience of the study cases. Based on the findings in Chapter 4, the four study cases respectively represent the four typologies of high-rise housing estates: slab high-rise housing estate, mixed slab and short-slab high-rise housing estate, short-slab high-rise housing estate, and mixed short-slab and tower high-rise housing estate. All study cases are located in a high-density urban area within a radius of 1,000 meters. It firstly examines the similarities and differences of the study cases at four different spatial levels, namely: urban neighbourhood, housing estate, dwelling building and dwelling unit. Following this, an in-depth analysis is presented to dissect the respective residential environment characteristics and residents' actual experience (actual usage situations) case by case, and outline the liveability evaluation that can be further examined by residents' liveability evaluation in Chapter 6.

Chapter 6 presents the outcomes of the questionnaire survey on residents' liveability evaluation. It first examines the content reliability and internal consistency of the questionnaire. It then summarizes the respondents' demographic features and residential environment features. Next, the holistic liveability evaluation (the 4 cases as a whole) is analysed to reveal the comprehensive liveability evaluation. Then, a comparison is made between the liveability evaluations of the four study cases. Finally, combined the findings and results in Chapter 4 and 5, the major liveability strengths and weaknesses of high-rise housing estates are identified and in-depth analysed.

Chapter 7 analyses the important theoretical issues on liveability of high-rise housing estates. Firstly, it examines the influence of residents' demographic features on their liveability evaluation. And then, it tests the correlation between residents' residential environment features and their liveability evaluation. Next, it analyses the correlations between residents' demographic features and their residential environment features. Finally, it proposes the comprehensive measurement of liveability, explores the indicators of liveability, and identifies the dimensions of liveability.

Chapter 8 summarises the major research findings. It examines the research aim, synthesises all the answers to the research questions and achieve the research objectives. Based on the conclusions, it proposes a series of recommendations on the planning, design and management of the future high-rise housing estates. The last section discusses the limitations of this study, and proposes the suggestions for potential future research.

Chapter two

Literature review: liveability of high-rise housing estates

'……, there is abundant evidence to show that high buildings make people crazy. Therefore, in any urban area, no matter how dense, keep the majority of buildings 4 stories high or less. It is possible that certain buildings should exceed this limit, but they should never be buildings for human habitation.'

---- Christopher Alexander (1977)

'……, given current urbanization trends, it would appear that high-rise housing is an inevitable consideration in many cities' search for answers to solve the problem of urban growth and housing shortage.……Notwithstanding the common negative descriptive about high-rise living in the literature, our findings lend support to the suggestion that high-rise living can be a satisfying experience.'

---- Belinda Yuen (2006)

2.1 Introduction

This chapter aims to understand the evolution of high-rise housing estates, review the existing empirical studies on liveability of high-rise housing, explore the research gaps, and summarize the potential liveability elements from the perspective of housing planning and design in order to establish a liveability evaluation model of high-rise housing estates.

The main body of this chapter consists of four sections. The first section discusses two basic concepts: liveability and high-rise housing estate. The former has become a significant environmental evaluation criterion; and the later forms the complex residential environment. The second section briefly reviews the historical evolution of high-rise housing estate, presenting the historical lessons and the contextual impacts which are important to understand the debates on liveability of high-rise housing, exploring the complicated forces to shape high-rise residential environment and promote the evolutions of high-rise housing estates. The third section then examines the previous arguments and studies on influences of high-rise living on residents, summarizing the existing research methodologies, grouping the pros and cons of high-rise housing for residents, generalizing the moderators that can impact residents' experiences and evaluation of high-rise housing, and finally proposing the current research gaps. The forth section gathers a series of liveability elements of high-rise housing estates which are useful for the evaluation and achievement of liveable high-rise residential environment from the perspective of housing planning and design.

2.2 Fundamental definitions: liveability and high-rise housing estate

2.2.1 Liveability: a user-centred environment evaluation

Liveability originates from the word: 'Liveable'. The term Liveable is defined by Concise Oxford English Dictionary (2009) as "generally meaning that something (e.g. a dwelling) is conducive to comfortable living and that life can be lived, made bearable or is supported". In Oxford Dictionaries Online, the definition of Liveable is '(of an environment or climate) fit to live in'. According to Cambridge Advanced Learner's Dictionary, explanation of Liveable is 'if a building or place is Liveable, it is suitable or good for living in'. liveability considers 'the suitability of a house for habitation and the capacity it has to offer comfortable living' (Concise Oxford English Dictionary,2009). A more precise definition of liveability is given as 'suitability for human living' by Merriam-Webster Dictionary. Above all, essentially, liveability is the ability of the environment to meet the people's living demands.

As a matter of fact, liveability has been a core aspiration of construction of the ideal living environment from Garden City (Rudlin and Falk 1999), to Modernism (Gold

2007) , to New Urbanism (Leccese and McCormick 2000), and to more recently, Sustainable Urbanism (Rio, Levi et al. 2012). However, the action-oriented planning and design have always been based on the professionals' expertise, experience and even utopian ideas, such as the modernist theories of Le Corbusier and the Charter of Athens, which resulted in a number of mismatches between good intentions and the end outcomes according to the description by Jacobs in – *Death and Life of Great America Cities* (1961). The lessons of modern urban development prompted 'environment creators', including policy-makers, developers, planners and designers, to pay more attention to 'environment users'. Meanwhile, with the rise of civil society and civil rights movements in the developed countries, the public as 'environment users' began to be more involved in the process of urban planning and design, and gradually taking a key role. Moreover, the development of statistics on the seemingly chaotic, diverse and unpredictable behaviour and demands of people have provided a better understanding and effective methods to explore liveability relating to users' experiences and feedbacks. As a result, liveability has developed, from an abstract concept, into an important realm of theory and practice of urban planning and architectural design.

Liveability versus Sustainability

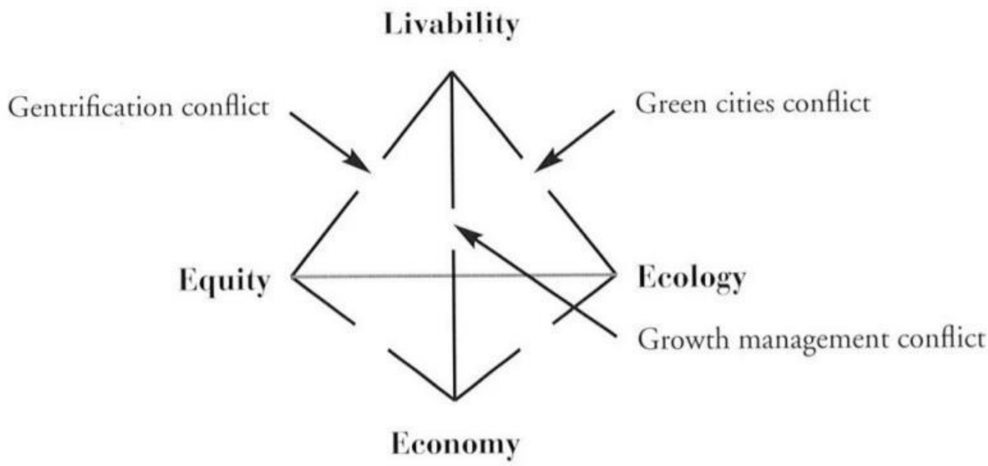


Figure 2- 1 The Sustainability/liveability Prism: Value Conflicts and Gaps

Source: Land Use Planning Challenges (Godschalk 2004)

With the rise of sustainable development in the later 1980s, liveability has been often used interchangeably with sustainability (O'Brien, Purser et al. 2006). In the Rio Summit in 1992, the conception of sustainable development was further developed, and included a very powerful commitment to the "local" -- Local Agenda 21, in which, the Habitat II agenda proposed the creation and maintenance of "liveable and sustainable" cities as the primary objective. Into the new century, David R. Godschalk (2004) constructed 'the sustainability/liveability prism (Figure 2-1) to point out the significance of liveability in contemporary urban theories and practices, and he considered liveability as a necessary complement to the notion of sustainability.

In a broad sense, 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* (O'Brien, Purser et al. 2006, p15).' Compared with sustainability, as summarized in the report: 'Liveability & Sustainable Development: Synergies & Conflicts' (BrookLyndhurst 2004), ***liveability is a user-centred environment evaluation that focuses on the local people's immediate needs and actual experiences of their environment from the subjective and micro perspective*** (Table 2-1).

Table 2-1 Liveability versus Sustainability

liveability	Sustainability
• User-centered conception from micro-perspective	• 3E-centered conception from macro-perspective
• Individual/community needs	• Collective/societal goals
• Subjective pursuit for the "Good life"	• Objective carrying capacity
• Short-term (Immediate)	• Long term
• Local scale (Based on individual living space)	• National/global scale
• About the environment	• For the environment

Source: summarized from the report of BrookLyndhurst (2004)

Content and Measurement of liveability

Differed with sustainability, none of a widely accepted framework of liveability has been established. In the existing literature, many researchers have reported liveability as a conception that is difficult to define and measure (see,Wheeler 2001, Balsas 2004, Heylen 2006, Leby and Hashim 2010). As Kristof Heylen (2006) pointed out, there are different views about the dimensions and indicators that should be included to capture the concept of liveability, and to a large extent, these different views stem from the different research objects and disciplinary perspectives. Many studies have indicated that the different spatial levels of the environment, such as city, neighbourhood and community, have different contents of liveability from different professional backgrounds. Urban researchers hold that liveability is an indicator system including the issues that are important to the urban environment and long-term well-being of people and communities, and that this system can either be used to evaluate the existing environment, or be used to guide future policy, planning and design (e.g.,Lennard, Lennard et al. 1997, Southworth 2003, Yuen 2011). Some studies focused on the liveability of neighbourhood and community, and identified a range of liveability elements based on both theoretical studies and practical experiences (e.g.,Omuta 1988, Wheeler 2001, Kihl, Brennan et al. 2005). Table 2-2 summarized the various definitions of liveability in different studies. As Leby and Hashim (2010) pointed, 'the term liveability is an umbrella to a variety of meanings, which depend both on the objects of measurement and on the perspective of those making those measurements'. An increasing number of scholars have recognized that liveability is a localized definition and directly related to environmental scale, with connotation that is changing and being decided by users' perceptions and experiences of their environment, and its measurement is an comprehensive analysis of users' feedbacks and evaluations in a specific context (Rio, Levi et al. 2012).

Table 2-2 Content of Liveability Defined in Different Studies

Balsas (2004)	EIU(2011)		Lennard et al. (1997)	Wheeler (2001)
City centre	City		City	Neighbourhood
1. Safe 2. Clean 3. Beautiful 4. Economically vital 5. Affordable to diverse population 6. Efficiently administered 7. Functional infrastructure 8. Ample parks 9. Effect public transportation 10. Interesting cultural activities 11. Sense of community	Stability	Prevalence of crime, threat of conflict, threat of terrorism	1. An attractive, pedestrian-oriented public realm 2. Low traffic speed, volume & congestion 3. Decent, affordable, well-located housing 4. Convenient schools, shops & services 5. Accessible parks & open space 6. A clean natural environment 7. Diverse, legible & educative built landscapes 8. Places that feel safe & accepting to all users 9. Places that emphasize local culture, history & ecology 10.Environments that nurture human community & interaction	
	Healthcare	Availability and quality of public and private healthcare, general healthcare		
	Culture and Environment	Climate, corruption, social/religious restrictions, level of censorship, recreation		
	Education	Availability and quality of private education, general public education		
	Infrastructure	Transport, housing, utilities		

Omuta (1988)	AIA(2008)	PLC (2011)	Kihl et al. (2005)
Neighbourhood	Community	Community	Community
1. Employment 2. Housing 3. Amenity 4. Education 5. Nuisance 6. Socio-economic	1. Design on a human scale 2. Provide choices 3. Encourage mixed-use development 4. Preserve urban centres 5. Vary transportation options 6. Build vibrant public spaces 7. Create a neighbourhood identity 8. Protect environmental resources 9. Conserve landscapes 10. Design matters	1. Built environment 2. Natural environment 3. Economic prosperity 4. Social stability and equity 5. Educational possibilities 6. Entertainment 7. Recreation	1. Transportation 2. Walkability 3. Safety & security 4. Shopping 5. Housing 6. Health service 7. Caring community 8. Recreation and cultural activity

O'Brien et al. (2006)		Leby and Hashim (2010)		Heylen (2006)	
City		Neighbourhood		Social Housing	
Environ -mental Quality	1. Noisier-Quieter? 2. Dirtier-Cleaner? 3. More or less congested? 4. Building quality, Better or Worse?	Social Dimension (Social relations)	1. Behaviour of neighbours (nuisance) 2. Community life and social contact 3. Sense of place	Quality of the dwelling / building	1. Acoustic isolation 2. Density 3. Comfort / Size 4. Maintenance
Place Physical Quality	5. Quality of the built environment 'product' 6. Levels of derelict land 7. Quality of parks and green spaces 8. Public realm quality	Physical Dimension (Residential environment)	4. Environment quality 5. Open spaces 6. Maintenance of built environment	Quality of the physical environ ment	5. Filthiness 6. Traffic safety 7. Maintenance 8. Service / Facilities
Place Functional Quality	9. Pedestrian journeys: easier or harder? 10. Public transport quality 11. Vitality and viability of services	Function Dimension (Facilities and services)	7.Availability and proximity of amenities 8. Accessibility 9. Employment opportunities	Quality of the social environ ment	9. Social cohesion / Sense of community 10. Communal problems 11. Social isolation
Safer Places	12. Crime levels 13. Anti-social behaviour	Safety Dimension (Crime and safety)	10. Number of crime 11. number of accidents 12. feeling of safety	Safe	12. Feelings of insecurity

Generally speaking, a liveability study should present the following process:

First of all, the object of study (specific environment type) is clarified and its subjects (environment users) identified; Second, the potential liveability elements of the specific environment type are summarized by reviewing the existing empirical studies and practical experiences; Third, survey data is obtained by way of case study on the users' evaluation on their living environment according to their actual experiences; and finally, the dimensions and indicators of liveability of the environment type in the specific context will be revealed by means of statistical analysis, and findings on the liveability of the study area is revealed.

It can be concluded that ***liveability is a user-centred environment evaluation based on the special context*** with the following characteristics:

1. it is a subjective evaluation that is carried out by the users;
2. it is a statistical evaluation that integrates many users' opinions;
3. it is a comprehensive evaluation that covers multiple aspects of environment;
4. it is a post-occupancy evaluation that is based on the users' actual experiences and perceptions of the existing built environment;
5. it is a dynamic evaluation that is grounded in the specific spatio-temporal background where and when the survey is carried out.

Overall, liveability research is a bridge that links environment users and environment creators including policy-makers, developers, planners and architects, and can help environment creators understand users' experiences and demands through their feedback. One of the most important purposes of liveability research is to explore the liveability problems of the existing built environment and to provide suggestions to solve the problems and improve the related policies and regulations, planning and design, construction and management (Whelan 2012). The core works of liveability research are to establish a model of measurement to examine the actual performance of the subject investigated, while the theoretical framework should be compatible with both the perception of environment users and the professional system of environment creators.

2.2.2 High-rise housing estate: a multi-level residential environment

The high-rise housing estate is a modern housing form that was generated under the influence of Modernism in the 1930s, and it is a new housing product that was produced according to utopian idea of designers, developers and policy-makers, without users' participation (Power 1993). According to the existing literature, the widely accepted definition was given by Power (1997,p20) and Turkington, etc. (2004,p3), when they defined the high-rise housing estate as *a purpose-built, distinct and discrete geographic housing area which is planned, designed, constructed and managed as a whole, and dominated by a number of high-rise residential buildings that are multi-family housings and are equipped with elevators due to their being over the maximum height which people are willing to walk up*.

Compared to other housing types, the high-rise housing estate constructs a more complicated residential environment. On the one hand, the high-rise housing estate forms a multi-level psycho-social environment which extends from the private personal and family spaces, the semi-private residential building shared with neighbours, the semi-public gated or open community, to the circumambient public urban spaces. The four spatial levels correspond to residents' environmental cognition from home, house, community, to neighbourhood. On the other hand, it constructs a multi-level physical environment which is composed of four spatial levels:

1. the unit for dwelling;
2. the high-rise building that contains multiple dwelling units;
3. the gated or open housing estate as a compound of dwelling buildings;
4. the surrounding urban neighbourhood as an extended context.

The four spatial levels cover the professional fields from interior design, architecture design, site plan, regulatory plan, urban design, to urban planning. The combination of the two dimensions and four spatial levels constructs the residential environment of high-rise housing estates. The four spatial levels – *dwelling unit, dwelling building, housing estate* and *urban neighbourhood* – form the fundamental residential environment components of high-rise housing estates, which can establish a platform to communicate residents and professionals who participate in the construction of the residential environment.

A ***dwelling unit*** is a self-contained residence which occupies a part of a residential building and normally consists of three basic functional spaces: family living space (living-room and dining-room), personal rest space (bedroom) and auxiliary service space (kitchen, bathroom, storeroom and balcony). The dwelling unit shares certain service facilities (stair, lift and corridor) and some constructional components (wall and floor) with other units within the same building. In other words, the dwelling unit is a private living space within a collective building. Therefore, this inherent contradiction of its physical environment could potentially cause the lack of privacy and safety, thereby affecting its psycho-social environment.

A ***dwelling building*** is a multi-family residential building which is composed of a certain number of dwelling units and includes some semi-public spaces and facilities for the occupants of individual dwelling units. For a high-rise dwelling building, some countries have different criteria for the minimum number of storeys and the range of building height. Generally speaking, high-rise housing is a multi-story building, tall enough to require the use of a system of mechanical vertical transportation such as elevators (Turkington, Kempen et al. 2004). Compared with other housing types, a high-rise residential building not only has greater impact on both the indoor and outdoor physical environment, such as natural lighting and ventilation, but also has direct influence on the psycho-social environment due to poorer accessibility to outdoor spaces on the ground and higher household density, which could cause overcrowding, lack of outdoor activities and decrease of social interaction, etc. (Gifford 2007, Zhu and Chiu 2011).

A ***housing estate,*** also called residential quarter or residential compound, from the perspective of the physical environment, is a residential area with a clear boundary, within which a group of residential buildings are built together as a single development that is planned, designed, constructed, managed and maintained in a unified way (Power 1997). Accordingly, a housing estate usually has only a few types and styles of dwelling and building design for special groups, which cause residential segregation and residential environmental homogenization (Reynolds 1986). From the perspective of psycho-social environment, driven by complex social, economic and cultural elements, many housing estates are gated communities defined as: ‘walled or fenced housing development, to which public access is restricted, characterised by legal agreements which tie the residents to a common code of conduct and collective responsibility for management' (Atkinson and Blandy 2005).

An ***urban neighbourhood*** is a complex and multi-dimensional conception that includes physical and psycho-social aspects of residential environment, and is essentially the external surroundings of housing estates. Neighbourhood is a comprehensive planning and design unit, the clustering of which forms towns and cities, and it is a geographical area where the daily-life facilities are provided for a majority of the residents within walking distance (Duany, Plater-Zyberk et al. 2003, Berk 2005). From the perspective of a resident, a residential environment is not just limited to its objective aspect of available and structured space, but also includes outside space as well as neighbourhood relationships (Forrest, La Grange et al. 2002, Yuen 2011). Neighbourhood is a spatial field where the residents have the sense of belonging to it or identification with it, and it has a significant contribution to the residents' cognition on their residential environment (Weenig, Schmidt et al. 1990, Talen 1999, Brown, Perkins et al. 2003). Either from the perspective of the physical environment, or from the perspective of the psycho-social environment, neighbourhood is an especially important part of residential environment of high-rise housing estates.

To sum up, high-rise housing estate constructs a multi-level residential environment where the resident is placed at the centre of a series of scales, which starts with the 'dwelling unit' and enlarges, like layers of an onion to form 'dwelling building', 'housing estate', and 'urban neighbourhood'. Although the four spatial levels, as the fundamental components of high-rise housing estates, have respective boundaries and scopes, they constitute an integral living environment for residents.

2.3 Historic retrospect: a process to improve the liveability of high-rise housing estates

High-rise housing constructs a distinctive residential environment with complicated psycho-social relations and hierarchical physical spaces, and it has become the dominant housing form in many cities all over the world against the backdrop of urbanization, urban regeneration and sustainable development. As the history of housing development since the industrialization illustrated, high-rise housing is continually evolving to adapt to various contexts, and the transformations were mainly prompted by social, economic and political trends, changes of policies and law, and the influence of reformers (Rudlin and Falk 1999). These changes are ultimately reflected in the evolution of the living environment, and some of them led to the generation of high-rise housing estate. During the period, residents have been gradually transforming from passive recipients to active participants, even decision-makers in the housing system. Correspondingly, liveability of high-rise housing has been experiencing such a change from being neglected to being taken seriously. This section will reveal the dynamic process of the evolution in five stages: the ancient high-rise housing, and the origin, boom, decline and rebirth of the modern high-rise housing estates, and seek to explore the trends from the top-down mode to resident-centred housing solutions.

2.3.1 The ancient high-rise housing: a practical housing solution to special circumstances

Throughout the history of architecture, it can be easily found that humans have been striving hard to build high-rise constructions based on a variety of reasons such as religion, belief or culture. Pyramids, pagodas, towers and cathedral's steeples are the perfect illustrations of various civilizations. Housing, however, as the most common architecture type, was seldom built very high before 20th century. As Louis Sullivan (1896) said: 'form ever follows function'. The nature of residence needs determinate the forms of housing. In fact, a striking feature of housing history is that the essential characteristics of basic dwelling types change very little over time, which reflect the continuity of the virtually unchanging determinants of housing needs (Sutcliffe 1974). Of course, there are some exceptions where the high-rise housing was chosen as the practical housing solution in some special environment. Generally speaking, they are constructed for the purpose of **economic interests** or **military security**, and produced two forms: urban tenement and defensive settlement.

In fact, the earliest high-rise residential buildings appeared in ancient Roman and other imperial cities where only a few urban citizens could afford their own houses, and the majority lived in apartment buildings, some of which might be ten or more stories and often occupied entire city blocks. These high-rise apartment buildings were called ‘Insulae’, or ‘Islands’ (Figure 2-2), because of the way in which they occupied the whole urban block (Aldrete 2004).

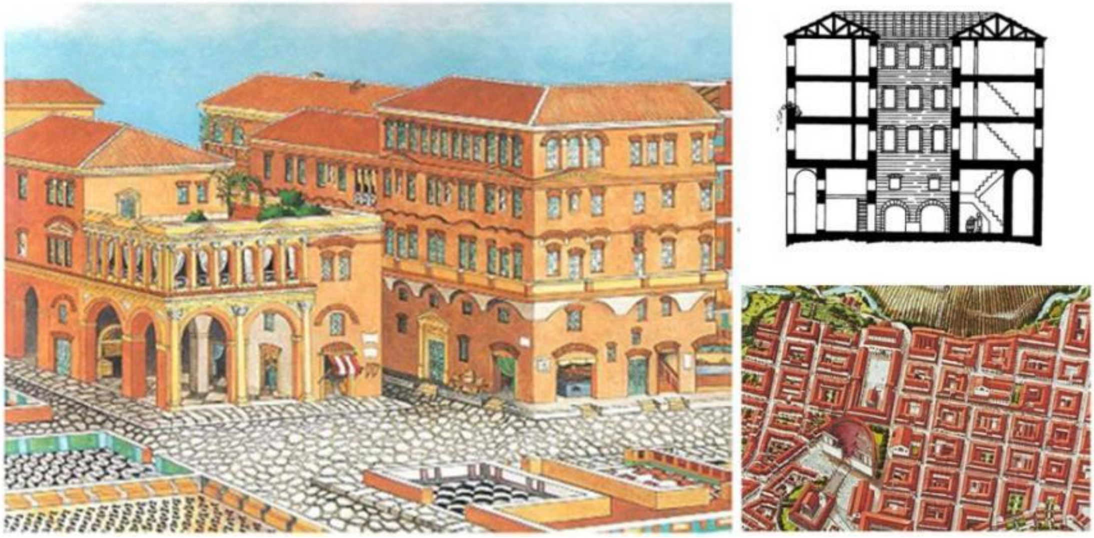


Figure 2- 2 Urban Tenements of Ancient Roman

Source: compiled from http://www.augustaraurica.ch/e/reise/bild-32.htm, http://www.bertsgeschiedenissite.nl/ijzertijd/eeuw1ac/flatgebouwen.htm and http://studyingsocieties.wikispaces.com/Housing

According to the book, ‘Daily Life in the Roman City: Rome, Pompeii and Ostia’ (Aldrete 2004), the high-rise apartment buildings were rented out to a wide variety of tenants of differing socioeconomic classes, and the lower floors were typically occupied by either shops or wealthy families, while the upper stories were rented out to the lower classes and had higher population densities. As there was no toilet on upper floors, the residents had to use the chamber pot. Despite legislation prohibiting such actions, full pots were often dumped out the window. In addition, because of the destruction caused by poorly-built high-rise Insulae collapsing, several Roman emperors set limits of 20–25 metres for multi-story buildings, but these limits were routinely ignored by the owners of Insulae who were only interested in higher profit from the rents (Aldrete 2004). In Arab Egypt, many high-rise residential buildings were built in the main cities, and some of them were seven stories tall that could reportedly accommodate hundreds of people. The two lower floors were for commercial and storage purposes and the multiple stories above them were rented out to tenants (Mortada 2003).

Another form of high-rise housing is based on the purpose of military and security. A famous example is the Old Walled City of Shibam (Figure 2-3), which has been called ‘one of the oldest and best examples of urban planning based on the principle of vertical construction' or 'Manhattan of the desert' (Gao 1999). In the old walled city, the houses are all made out of mud bricks and are 5 to 16 stories high, with each floor having one or two apartments. This building technique was implemented in order to protect residents from attacks (UNESCO 1992).

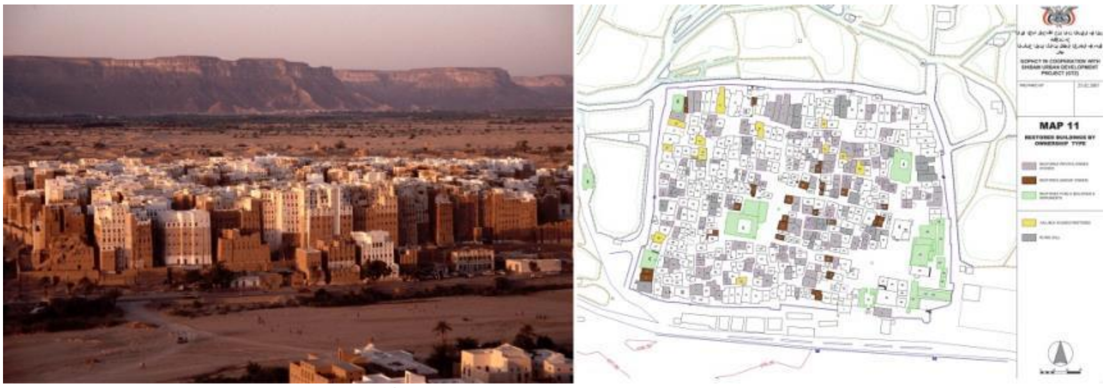


Figure 2- 3 The Old Walled City of Shibam

Left: Birdview from south; Right: Master plan of whole city
Source: compiled from photo by Jialiang Gao and http://78.136.16.169/Web_Images%20selection/Shibam/drawings_jpg/02_Drawing_Shibam.jpg

Another early example of high-rise urban block was in 17th-century Edinburgh, where a defensive city wall defined the boundaries of the city (Figure 2-4). Due to the restricted land area available for development and the quickly growing demand for housing, the houses increased in height instead. Buildings of 11 stories were common, and there are records of buildings as high as 14 stories. Many of the stone-built structures can still be seen today in the old town of Edinburgh. However, because of the poor liveability such as no elevator, lack of water supply and toilet, high-rise housing has been considered as a practical housing form, and has not become a main residential form until the early twentieth century, when they began to be accepted and constructed as the effective housing solutions for the working-class during industrialization and urbanization in Europe and America.

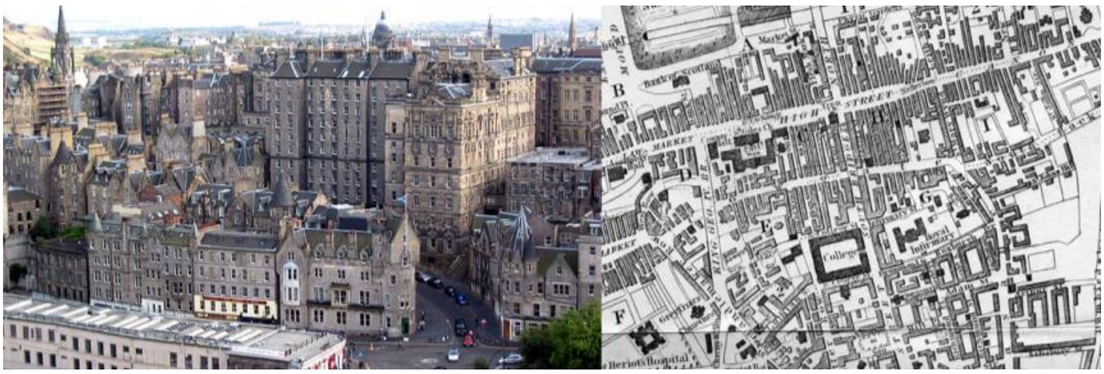


Figure 2- 4 High-rise Urban Tenements in Edinburgh's Old Town

Source: http://files.list.co.uk/images/2009/09/24/old-town-pic-LST048302.jpg

2.3.2 The origin of high-rise housing estate: a modern housing form based on rationalism and functionalism

Industrialization was the fundamental driving force for the origination of high-rise housing estates. On the one hand, as Peter Hall (1975) has pointed, industrialization not only triggered the urban spread of the original industrial and port cities, but also promoted the construction of new industrial towns and cities close to the energy and resources, which was accompanied by the massive housing developments in order to provide enough residences for the mass working-class in volume and with speed. Under the circumstances, upward building became the reasonable option. As quoted by David Rudlin and Nicholas Falk (1999), in 1849 an article argued that 'the time has now arrived when the expansion and growth of the city must be upwards in place of outwards – when 'house' must be reared above each other…instead of straggling miles farther and farther away from the centre' (Burnett 1986). Meanwhile, because the multi-storey working-class tenements could generate a good profit for investors, more and more blocks were rapidly built by the early housing associations in industrial towns and cities (Rudlin and Falk 1999). However, due to the low-quality and lack of comprehensive plan and control, the urban and housing environment began to rapidly deteriorate and became overcrowded, with insufficient-infrastructure and full of pollution and social problems, which resulted in the appearance of vast urban slum areas (Figure 2-5).

Figure 2- 5 Slum Tenements in the Industrial Revolution

Left: Tenement-house in Mulberry Street, New York; Right: Victorian Tenement in London
Source: compiled from http://www.assumption.edu/users/mcclymer/bedfordprototype/toc/default2.htm and http://www.johnnydepp-zone.com/boards/viewtopic.php?f=93&t=47221

Under these conditions, the utopian socialism began to rise in Europe. Some industrialists, such as Robert Owen, and Titus Salt, started to experiment with new ways in order to provide better residential environment for the working-class (Figure 2-6), which influenced the *Garden City Movement* in terms of both theory and practice.

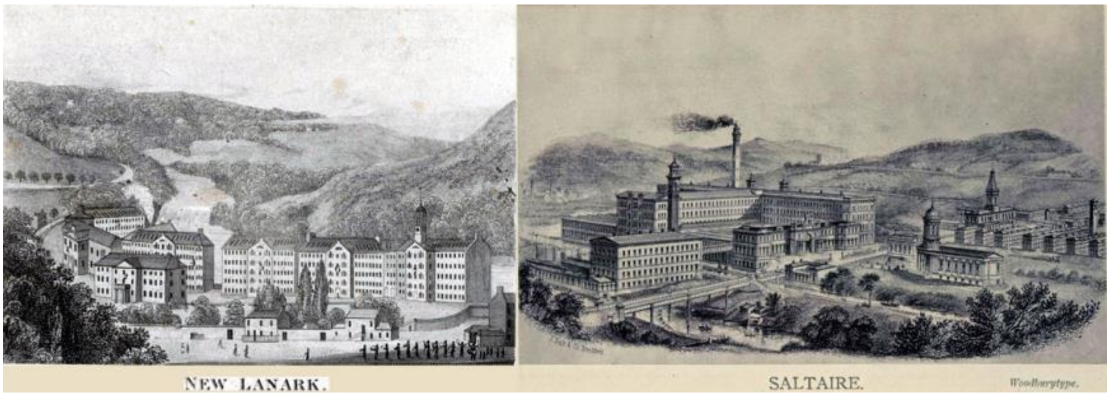


Figure 2- 6 Utopian Industrial Villages

Left: New Lanark by Robert Owen in 1800; Right: Saltaire by Titus Salt in 1853. The workers were provided with decent homes, schools and evening classes, free health care, and affordable food in the new industrial villages.
Source: compiled from http://www.gtj.org.uk/en/small/item/GTJ70122/ and http://www.bl.uk/learning/images/victorian/extra/large107260.html

The influential idea—'Garden City' was first systematically exposited by Ebenezer Howard in his book: *Tomorrow: A peaceful path to real reform* in 1898, republished in 1902 as *Garden Cities of Tomorrow.* The garden city ideas, such as the 'Three Magnets' and 'Social City' (Figure 2-7), not only constructed the theoretical basis of modern town and country planning, but also promoted the garden city movement from Europe to America, which had in-depth impacts on modern housing development (Rudlin and Falk 1999).

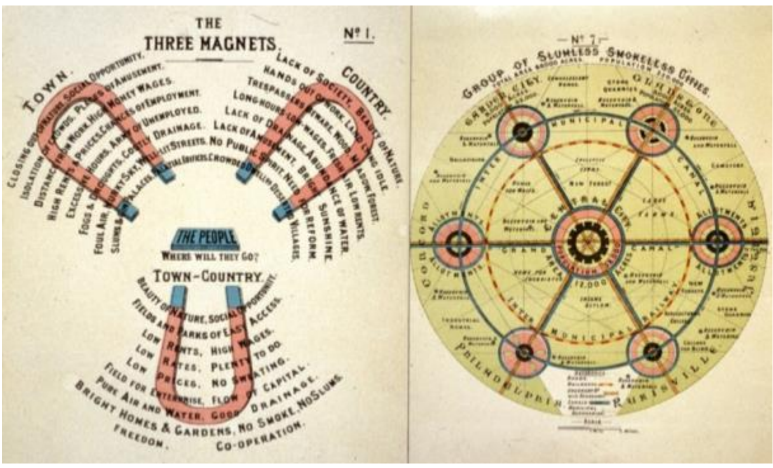


Figure 2- 7 'The Three Magnets' and 'Social City' of Ebenezer Howard

Source: compiled from Howard's Garden Cities of Tomorrow

On the one hand, Garden Cities opened the gate of the first wave of suburbanization, and the family-house with a garden in a low-density suburban neighbourhood became the most ideal housing form for the middle- and upper-classes. With the labour movement after the First World War, the early low-quality tenements began to be demolished as a part of slum clearance, and public housing estates for the working-class were developed according to the garden city model. The top-down pattern of large-scale housing development gradually cut the relationship between planners and residents, which formed the hidden trouble of housing planning system (Power 1997). The Garden City movement had a significant impact on the development of large-scale public housing estates around the world after the Second World War (Turkington, Kempen et al. 2004).

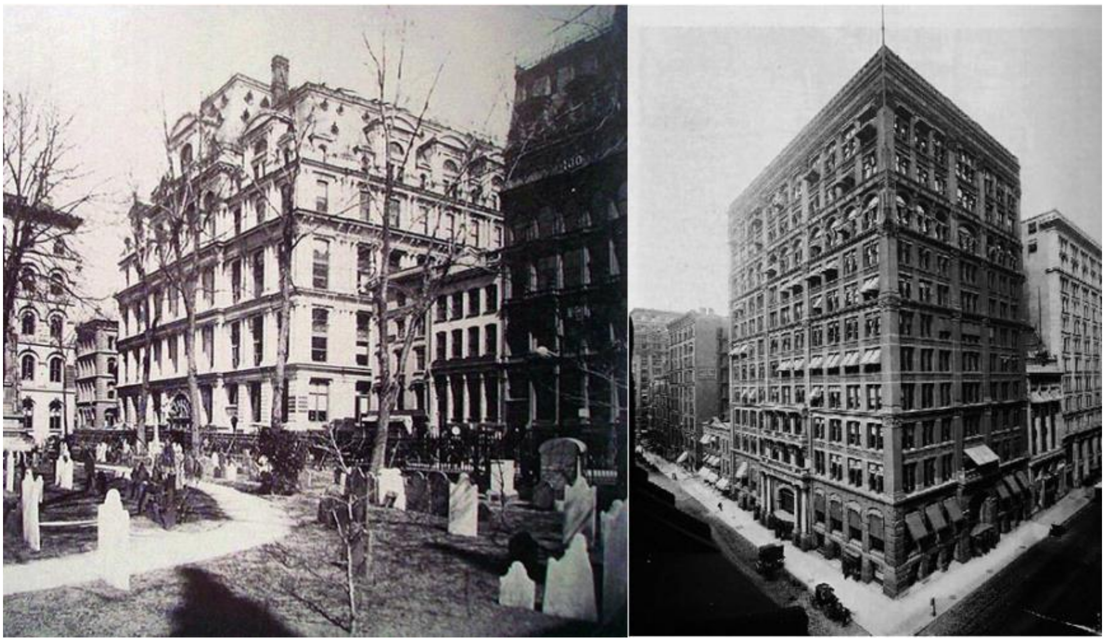


Figure 2- 8 the Early High-rise Buildings

Left: Equitable Life Assurance Building firstly equipped passenger elevators; Right: Home Insurance Company Building firstly used steel-structure, and was regarded as the first modern high-rise building. Source: compiled the photo from http://en.wikipedia.org/wiki/File:Equitable_Life_Assurance_Building_1870.jpg and http://upload.wikimedia.org/wikipedia/commons/3/38/Home_ Insurance_Building.JPG

On the other hand, industrialization promoted the economic development and technological improvement. In America, the first high-rise building with passenger elevators, the 'Equitable Life Assurance Building', was constructed in New York in 1870. By 1884, the first steel-structure high-rise building, 'Home Insurance Company Building', was built in Chicago, which is considered to be the first skyscraper in the world (Figure 2-8). With a number of structural and mechanical inventions, such as steel reinforced concrete, high-speed elevator, water pumps, air-conditioning systems, and flush-toilets, tower blocks began to become the main building types, and consequently changed the landscape of many great cities in USA and Europe. Although the majority of the early high-rise buildings were high-cost commercial architectures in the downtown areas of the great cities, high-rise was gradually accepted as a new modern housing form by the modernist reformers such as Le Corbusier and Gropius, who promoted the planning, design and construction of High-rise housing estates in the *Modernism Movement*.

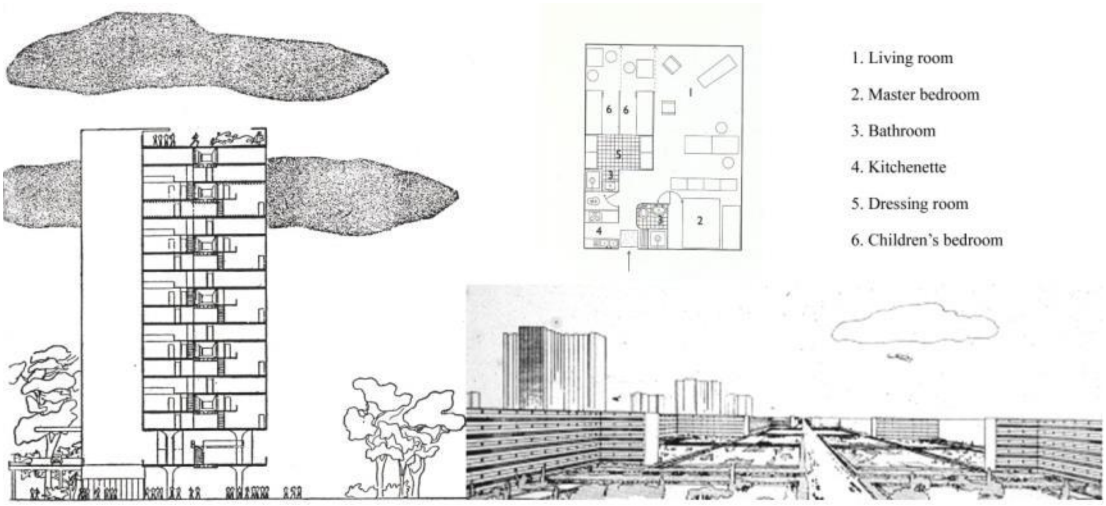


Figure 2- 9 Le Corbusier's Ville Radieuse Unit

Left: section of a typical cross-over duplex block; Right-up: layout of a typical 'transformable' single-storey apartment; Right-down: view of a group of 'Ville Radieuse unit'
Source: compiled from 'Le Corbusier'(Frampton 2001) and 'the Radiant City'(Corbusier 1933)

Modernism is a thought that sought to replace the tradition with industrialized order, logic and standardization, and is characterized by rationalism and functionalism. In the domain of housing planning and design, Le Corbusier in France, the Bauhaus in German, Vkhutemas in the Soviet Union and Chicago school in America played important roles during the pre-war Modernism Movement. Le Corbusier was one of the most important modernist architects and urbanists in the 20th century. In his two influential books: *the City of Tomorrow* in 1922 and *La Ville Radieuse* in 1933, he established his utopian vision of the future cites and exploited the potential of new technology, such as the car, aero-plane etc. especially high-rise building. He integrated Tony Garnier's functional zoning and residential quarter, and American skyscraper, with the influence of communal dwelling in the Soviet Union in developing his mass high-rise housing prototype (Frampton 2001), which was called the 'Ville Radieuse unit' (Figure 2-9). In Brussels in 1930, he displayed his belief that the Radiant City and the high-rise block offered the only solution to the universal housing problem at the third CIAM (International Congresses of Modern Architecture). This was considered to have a great impact on policy-makers, planners and architects (Power 1993).

At the same time, the architects of Neues Bauen (New Building) represented by Martin Wagner, Ludwig Mies van der Rohe and Walter Gropius, were eager to build as much cost-effective housing as possible, partly to address Germany's post-war housing crisis, and partly to fulfil the promise of the 1919 Weimar Constitution, in which it was written to provide '*a healthy dwelling*' for all Germans. They abandoned the low-rise garden-city style housing development, in favour of the much denser multi-story apartment blocks, and drove the technical definition of subsistence dwelling in terms of minimally-acceptable floor space, density, fresh air, access to green space, access to transit, and other such resident issues (Figure 2-10).

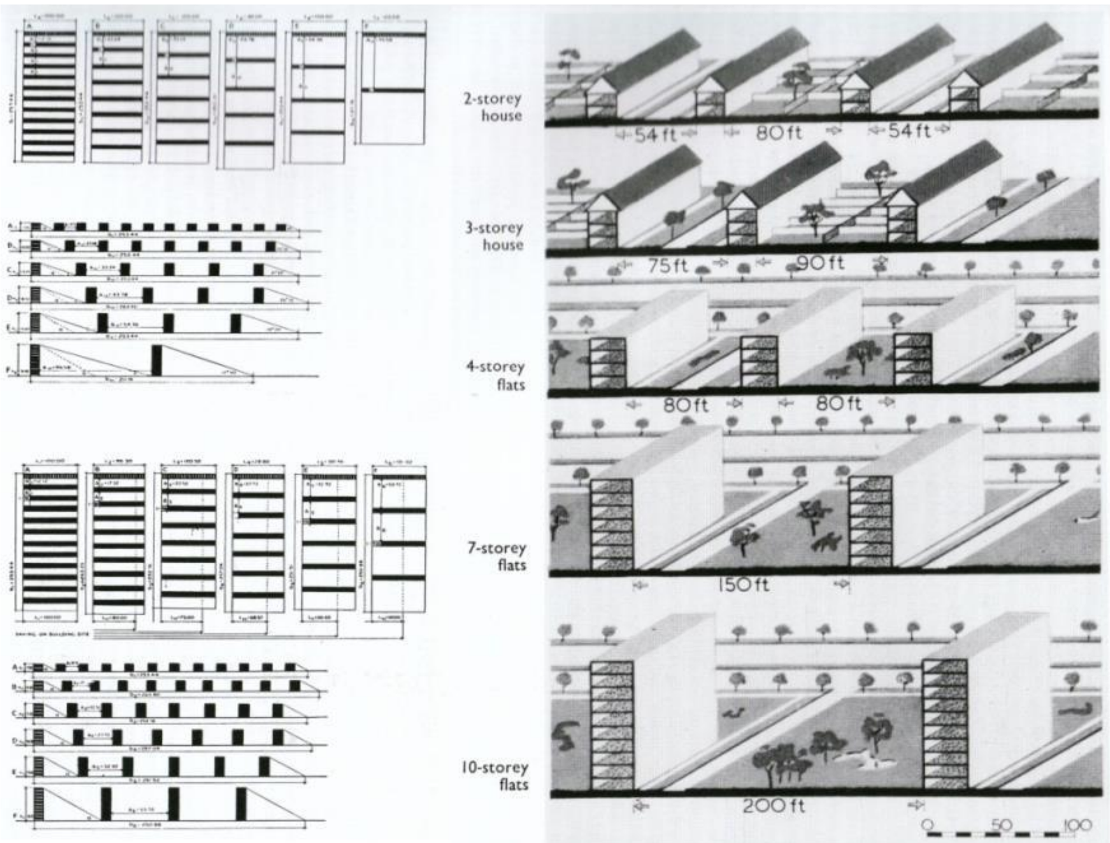


Figure 2- 10 A Geometrical Demonstration of the Advantages of High-rise Blocks over Houses: More Light and More Green Areas

Left: a simplified version of Walter Gropius's analysis in The New Architecture and the Bauhaus, 1935; Right: Diagram from E. J. Carter & E. Goldfinger, The County of London Plan, 1945.
Source: compiled from Tower Block: Modern public Housing in England, Scotland, Wales, and Northern Ireland(Glendinning and Muthesius 1994)

These modernist architects not only established the Bauhaus to promote their theory and educate new architects, but also practiced their modernist philosophy in reality projects. Between the two world wars, mass modernist multi-storey housing estates for the working-class were constructed, and these German housing estates were regarded as the direct predecessors of the modern high-rise housing estates (Turkington, Kempen et al. 2004). A classic example is the Great Settlement of Siemens City where the slab residential buildings were arranged in parallel rows in order to guarantee minimal cost, maximum amounts of sunshine for all. This planning formation was called 'Zeilenbau' (Figure 2-11), and this modern housing model was gradually accepted by other European countries.

Figure 2- 11 the Great Settlement of Siemens City

That was a typical 'Zeilenbau' formation (parallel slab buildings), and directed by Martin Wagner, planned by Hans Scharoun, and designed by Hans Scharoun, Walter Gropius, etc. between 1929 and 1934.
Source: compiled the photo from http://www.stadtentwicklung.berlin.de/denkmal/denkmale_in_berlin/de/weltkulturerbe/siedlungen/siemensstadt.shtml

As the Bauhaus in Germany promoted the development of modern housing estates in Germany-speaking Europe, Vkhutemas (the Russian state art and technical school) in Soviet Union promoted the planning, design and construction of collective housing estates for workers in the eastern European countries. Finally, all of these theories and practices together gradually constituted the principles of the modernist housing estate through a set of CIAM from 1928 to 1939, which were important contents of 'the Functional City' and were widely accepted by architects, urban planners and governments in Europe and America (Mumford 2000). They believed that 'it was possible to construct a new and egalitarian society by providing dramatically improved housing and environmental conditions for working classes' and the modern high-rise blocks were 'the universal solution to the housing problem'(Turkington, Kempen et al. 2004,p5).

However, due to the Second World War, much of Europe had descended into social and economic chaos, and the construction and development of high-rise housing began to cease inevitably. By contrast, in USA, benefitted from the stable development of society and economy due to its distance from the two world wars, another pattern of high-rise housing estates – 'tower block estates' were developed. One of the earliest ones is Castle Village in New York (Figure 2-12), which was delivered in 1939, consisted of five fourteen-storey apartment towers on a site of 3.08 hectares. Another example is Parkchester in New York City, which were built in large scale from 1939 to 1942, and incorporated 51 groups of buildings to house 12,000 families (The New York Times,1939). These high-rise housing estates were built in tower shapes and most of the buildings were over ten storeys. These were the truly modern high-rise residential buildings and inherited the ideas of 'Chicago School'. Some new technics and practices, such as reinforced concrete construction, the cross architecture design and the towers in a park layout had a profound impact on the later planning and design of social and affordable high-rise housing.

Figure 2-12 View and Plan of Castle Village in New York

It is one of the earliest tower high-rise housing estates, which was designed by George Fred Pelham. The cross tower form made most flats have the view of Hudson River.
Source: compiled the photos from http://www.panoramio.com/photo/23285345 and http://www.castlevillage.com/

It is worth noting that most of the first generation of high-rise housing estates in Europe and America have been highly successful and sustainable until now (UNESCO 2008, Wikipedia 2011), which benefited from careful planning (the functional integration into cities), rational design, high-quality construction, effective management and maintenance (Turkington, Kempen et al. 2004). After the World War II, high-rise housing estates began to become the main housing forms under the promotion of a variety of elements, and a global boom of construction of high-rise housing estates was staged in 1960s.

2.3.3 The boom of high-rise housing estate: an utopian housing solution to huge housing shortage

During World War II, lots of countries sunk into social and economic chaos around the world. Many cities had been destroyed, which resulted in the lack of sufficient and adequate housing. Immediately after the war, the family formation and the post-war 'baby boom' further deteriorated the situation. It became a priority to meet the housing shortage and improve dwelling conditions in most countries. Economic recovery, population growth, rural-urban migration, and immigrant from other countries further intensified housing shortage in many cities. The huge gap between housing supply and demand promoted the governments to seek a quicker, cheaper and more efficient housing solution. During this period, the state played the central role in financing and organizing house building, and Modernism exerted more widespread influence on housing planning and design. From the viewpoint of housing planning, the policy-makers and actors, being influenced by 'Modernism' since 1930s, believed that the 'functional city' composed of high-rise housing represented a more effective, equal and fair society (Frampton 2001). They thought that the functionally integrated high-rise housing estates could create a social fabric with close neighbourhood connections, and provide the opportunity to meet people, encourage interactions and exchange ideas (Roeloffzen, Lanting et al. 2004). Although there was great concern that high-rise buildings could have some negative impacts on the residents, at that time, there was no sufficient evidence to confirm the relationship between the high-rise residential environment and the negative effects (Turkington, Kempen et al. 2004).

Housing design after the Second World War was faced with the huge and urgent housing shortage and fragile economy. The efficiency and low-cost provision of housing became the priority in the housing system, and the ideology of modernism in architecture changed from Louis Sullivan's 'form (ever) follows function'(1896) to 'form follows finance' (Willis 1995). The planning, design and construction of housing estates began to seek optimized investment and minimized cost. Meanwhile, the communication between the policy-makers, designers and the users was ignored in the process, and the guidelines and handbooks from the authorities and social organizations became the discipline for the planning and design of housing estates (Glendinning and Muthesius 1994). As a result, the housing system was operated in a top-down mode, and high-rise housing estates became a utopian housing solution (Figure 2-13).

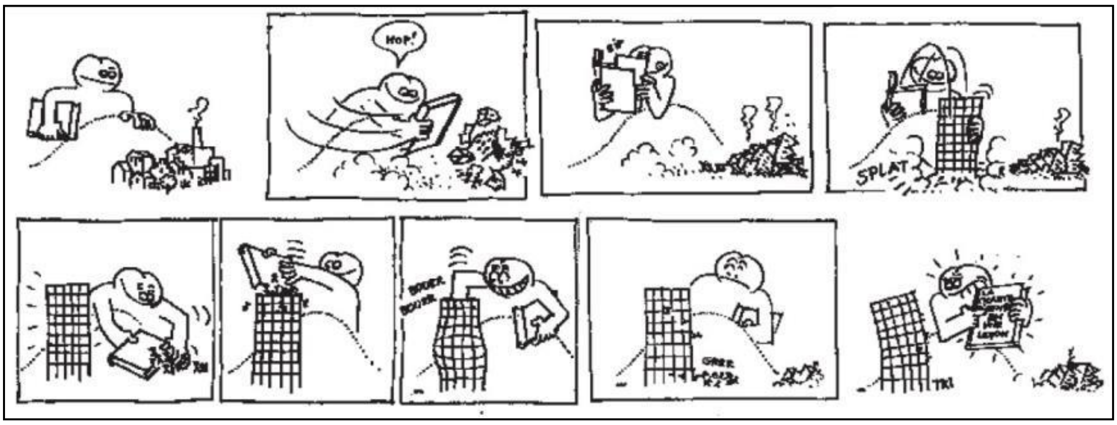


Figure 2- 13 Top-down and Utopia High-rise Housing Solution

Source: compiled from the book: High-rise housing in Europe (Turkington, Kempen et al. 2004)

A series of other elements also promoted the formation of utopian housing solution and made high-rise housing the chief housing form at that time. Firstly, because many authorities, housing providers and even residents deemed that high-rise housing symbolized the status, urbanism and modernity, the national governments and investors provided huge amount of stimulus to develop high-rise housing. In many countries, high-rise housing received the largest subsidies from public housing programmes during this period (Power 1976). Secondly, in order to protect the natural environment from urban sprawl, high-rise housing became the best solution to save land while providing more dwellings. Many studies compared the land use of high-rise housing with that of other housing forms, and claimed that urban high-rise housing could be built at higher densities whilst achieving more privacy, more open space and freeing people from the gardening job (Beedle 1977, Helleman and Wassenberg 2004). Thirdly, the development of technological innovations was an important promotion for the mass construction of high-rise housing estates. As Wassenberg *et al.*(2004) noted, 'building in concrete, the use of large prefabricated components, establishing housing elements on site and the rationalization of the building process all made high-rise technically possible'. Industrialized housing production technologies resulted in more large-scale construction of high-rise housing estates and reinforced the view that every social problem had a technical solution. Last but not least, from the viewpoint of the residents, the brand new high-rise housing provided such modern amenities as hot and cold water supply, shower or bath, central heating and rubbish disposal system. Collective facilities such as childcare, laundry, shop and recreation were all built to make high-rise living both comfortable and convenient. The majority of high-rise housing estates were public housing (social housing), which were owned and managed by the state or non-profit organizations, or by a combination of the two, and received subsidies from the public housing programmes, hence the residents could enjoy better living environment with reasonable rent. Therefore, in the early time, the majority of people accepted the high-rise living and believed that high-rise housing represented a modern life-style and improvement of overall life quality. Above all, these motives -- housing shortages, modernistic philosophies, government stimulus, achieving reductions in land uses, technological progress, and new lifestyles – together promoted the large-scale high-rise housing estates as the utopian housing solution and boosted the construction of high-rise housing estates during the 1960s and 1970s in the vast regions from Europe, North America, and Australia to several developed Asian countries and regions, such as Japan, Singapore and Hong Kong.

Similar motives produced similar outcomes. First of all, in these countries, huge amount of high-rise housing estates were built at high speed. In France, for example, between 1960 and 1980, nine million dwellings were constructed (Turkington, Kempen et al. 2004). In the UK, according to the statistical data of the Department of the Environment in 1998, 297,000 high-rise flats were constructed in the years between post-war and mid-1970s, which is over 92% of all high-rise dwellings. Next, the majority of high-rise housing used the prefabricated construction and standardized design. Dwelling units could be produced to uniform standards in 'housing elements', with cast concrete panels replacing laborious work with bricks and mortar. Economies of scale were achieved through repeat construction, with tall blocks and uniform streets determined by the technology of the tower crane. In addition, according to the same ideology of Modernism planning and design, these high-rise housing estates were located in 'green field' sites at the periphery of existing towns and cities, where tower cranes could repeat their erection in linear streets. While local amenities were planned for estates, they were often inadequate or not provided at all. Within the high-rise housing estates, collective space, such as lodge, corridors, lifts, green area, etc. were provided for communal use of the residents. The Bijlmermeer neighbourhood is a famous example that was designed and constructed in the suburban area of Amsterdam as a single project, where a series of nearly identical high-rise long-slab buildings were laid out in a hexagonal grid and housed almost 100,000 people (Figure 2-14).

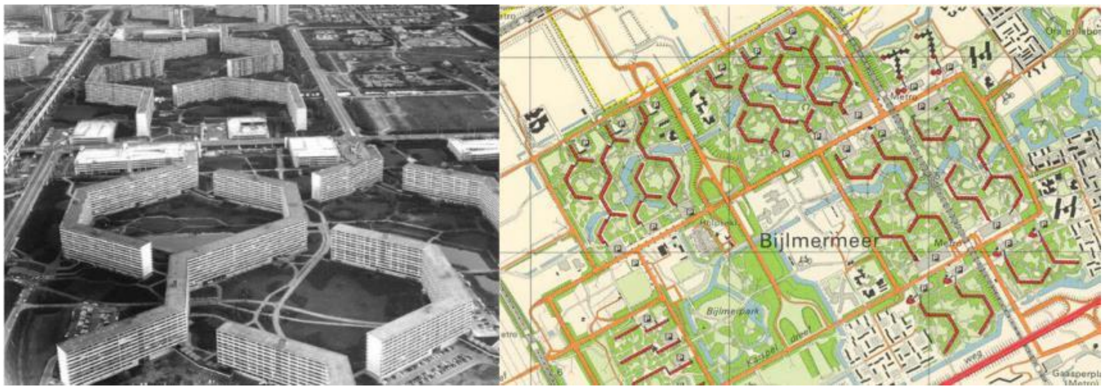


Figure 2- 14 Bijlmermere in Amsterdam, Netherland

This is one of the biggest high-rise housing estates in Europe. Meantime, it is one of the influential regeneration projects on the post-war large-scale high-rise housing estates.
Source: compiled from http://bryla.gazetadom.pl/bryla/51,85298,7059834.html?i=7 and http://www.skyscrapercity.com/showthread.php?t=1344943

Different from the interwar high-rise housing estates, the second generation of high-rise housing estates built in post-war period still struggled to attract the middle class families and change the stigma of crime and poverty (Frank 2004, Helleman and Wassenberg 2004, Stal and Zuberi 2010). Despite the advantage of the 'top-down' planning on the speed to resolve the urgent housing shortage and achieve an utopia housing solution, the lack of understanding and attention to the liveability of high-rise housing inevitably resulted in the emergence of problems and the decline of high-rise housing estates.

2.3.4 The decline of high-rise housing estate: a problematic housing form rejected by residents

The post-war high-rise housing estates were constructed during 1960s to mid-1970s in order to supply the people with modern life style and better living environment. Most of them were affordable housing (council housing and public housing) and were part of the 'Slum Clearance' programmes. However, just over a decade later, high-rise housing started to be considered as a problematic housing form with a lot of high-rise housing estates becoming new slums with stigma, which were waiting for regeneration, even demolish (Power 1999, Frank 2004, Kathy 2004, Roeloffzen, Lanting et al. 2004). In fact, in the early post-war years, some studies indicated that high-rise was a problematic housing type, and some evidence of suspecting the liveability of high-rise living environment had emerged. In the USA, for example, Bauer (1952) claimed that 'almost universally, families with growing children apparently want to live at ground level'. In a further example from England, the study which was carried out by Ingrid Reynolds and Charles Nicholson in 1967 showed almost 80% of the families with children under five-years-old were unsatisfied with high-rise living (Marcus and Hogue 1976). Similar evidence of families' preference for single-family houses also emerged in the Netherlands, Sweden and Denmark in the 1960s, and some countries made policies to forbidden occupancy of the families with children (Turkington, Kempen et al. 2004).

Several authors have attempted to classify the range of problems affecting high-rise estates, including Power (1997), and Turkington (1997), and Frank Wassenberg et al. (2004, p11,12) have identified the following problems:

'***Structural problems****: usually caused by untried construction methods and poor quality materials, and associated for example, with asbestos pollution, poor sound insulation, dampness, condensation and draughts.*

Internal design problems*: associated with small rooms, inadequate central heating, sanitary equipment and storage space; the absence of amenities such as lifts and communal facilities, and inadequate external space.*

Urban design or spatial problems*: associated with poor location, high building density and problems of traffic and noise pollution.*

Internal social problems*: including noisy and other anti-social behaviour; crime and insecurity and poor neighbour relations.*

Financial problems*: for tenants of high rents and service charges, and for landlords, problems of high rent arrears and vacancies, high maintenance costs and large operating losses.*

Competition problems*: concerned with the low market position of an estate and poor image etc.*

Management and organisational problems*: arising from inadequate maintenance and insufficient resources.*

Legislative problems*: concerning the ownership of flats and blocks and the space around them.*

Wider social-economic problems*: including high unemployment, poor schooling, drug addiction etc. and intensified where households in similar circumstances are concentrated together.*'

These problems resulted in the deterioration of the residential environment of high-rise housing estates. Many of high-rise housing estates that were built in 'Slum-Clearance Programmes' finally became 'New Slums'. Some of them have been suffering the stigma and the poor residential environment, some of them have been regenerated and others were gradually demolished after mid-1970s (Figure 2-15).

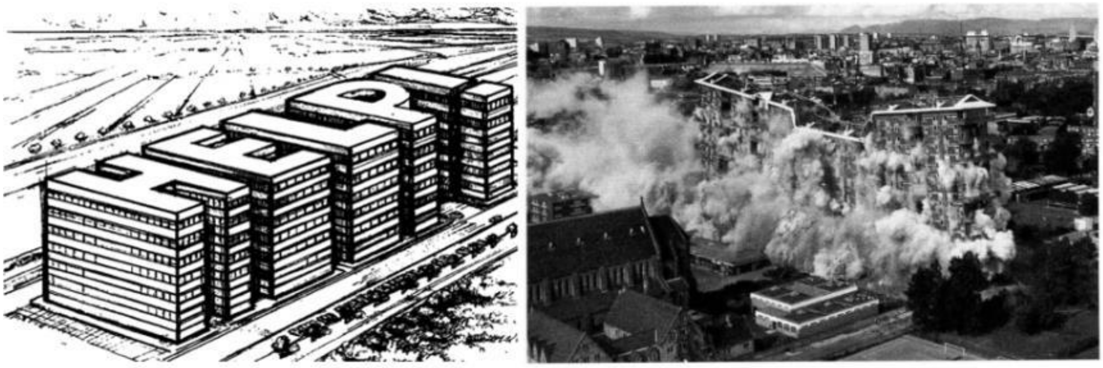


Figure 2- 15 Problematic High-rise Housing Estates

Left: to describe the situation of problematic high-rise housing estates in 1976; Right: 'Blow down' of Hutchesontown high-rise blocks in 1993 in the UK.
Source: compiled from pictures in 'High-rise housing in Europe' (Turkington, Kempen et al. 2004) and 'Tower Block' (Glendinning and Muthesius 1994)

In fact, the decline of high-rise housing estates is a complicated process, which is based on the complexity of the housing system. According to the comprehensive model of Prak and Priemus (1986), this process can be identified as cycles of decline: technical decline (affecting the high-rise housing estates' physical environment); social decline (affecting the high-rise housing estates' psycho-social environment) and financial decline (affecting the economic sustainability and viability of high-rise housing estates). All three cycles may influence and reinforce each other, and are also affected by external elements including government policies, wider social and economic trends and the policies of the owners. Other authors, such as Power (1997), Miles Glendinning and Muthesius (1994), and Roeloffzen et al.(2004), have analysed the problem of spirals of decline. Despite of various answers on the decline of high-rise housing estates, the most fundamental reason is the ignorance of residents' participation, which made the residential environment of high-rise housing estates unable to meet the needs of residents and finally resulted in residents 'vote by feet' or 'express by actions'. As Wassenberg *et al.*(2004) stated that it is difficult to establish how widespread these views were, as in the early years of high-rise construction, due to the top-down solution model, consumers' opinions were neither invited nor heard and the views of professionals held sway. Many cases studies on regeneration of post-war high-rise housing estates have acclaimed that 'listening to the people' and 'doing together with inhabitants' is one of the significant elements to achieve success in the renewal (Tai 1988, Seik 2001, Frank 2004, Helleman and Wassenberg 2004, Appold and Yuen 2007). These practices and researches laid the foundation for the re-emergence of high-rise housing estates in the whole world.

2.3.5 The rebirth of high-rise housing estate: a sustainable housing solution in high-density urban area

Since the publication of the Brundtland Report on sustainable development, a global movement have been carried out to search and achieve urban development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Among the various sustainable urban forms advocated, the concept of compact city development has become increasingly popular as a spatial strategy to counteract the environmental ills of urban sprawl (Masnavi 1999, Burgess 2000). Thomas and Cousins (1996, p 156) have summarized the benefits of the compact city which can improve urban sustainability: 'less car dependency, low emissions, reduced energy consumption, better public transport services, increased overall accessibility, the re-use of infrastructure and previously developed land, the rejuvenation of existing urban areas and urban vitality, a high quality of life, the preservation of green space, and a milieu for enhanced business and trading activities.' However, there is considerable debate surrounding the appropriateness of urban intensification as a means of ensuring a more sustainable development pattern (Howley 2010). Especially for high-rise high-density housing development, there are also a lot of debates on its sustainability (Rudlin and Falk 1999, Zhu and Lin 2004, Yuen 2007).

Inevitably, each housing form has its advantages and disadvantages in terms of sustainability. For high-rise housing, its main merits can be summarized as the following points. Firstly, it could save land consumption, preserving more natural and green space and thus maintaining ecosystem dynamics (Zhu and Chiu 2011). Because cities are often located near fertile agricultural lands, they tend to consume high quality agricultural land when they expand in space. Therefore, intensification of land use by building high-rise is an effective method of reducing sprawl onto farmland. Secondly, high-rise housing could achieve higher energy efficiency and lower resource consumptions (Rudlin and Falk 1999). For housing the same number of residents, a high-rise block consumes less building material with shared foundations, roofs and partition walls, compared with other types of housing. High-rise buildings are also potentially more energy efficient since they have less exposed wall area and the dwelling units often have no heat-loss roof. High-rise buildings also reduce the cost of environmentally-friendly services by recycling programmes, such as waste collection, facilities recovering waste materials, the marketing of waste materials, and the control and treatment of effluents and other forms of pollution (Travers 2001). High-rise development also facilitates the reduction of transport energy consumption because higher residential densities enhance the viability of public transport (Neuman 2005). Thirdly, due to the agglomeration of residents living in high-rise housing, various services can be located within walking distance from dwellings and meet the different needs of different household types. This also enhances the potential for walking and cycling, thereby enabling various population groups (children, teenagers, the elderly, the handicapped, and those without cars) to avail themselves of resources independently (Zhu and Chiu 2011). Meanwhile, higher densities meant that more people could be housed or could work closely together, requiring shorter lengths of cables, pipes and sewers, bus routes, roads and also fewer but may be larger commuting facilities, such as shops, hospitals and schools (Jenks, Burton et al. 1996, Travers 2001).

Nonetheless, high-rise housing also has disadvantages to influence its sustainability. First of all, high-rise housing always increases the burden of a city’s infrastructure system. The more high-rise housing is developed, the more supporting public facilities and infrastructure are needed to be built, which resulted in intense competition for limited land. But such competition always led to the deficiency of facilities, urban land and residential environment (Scoffham and Vale 1996). In addition, compared to the other housing types, the operation energy of high-rise housing is usually higher due to the use of additional facilities, such as lift, water supply system, air-conditioning (Tory 1996). The construction of high-rise housing is likely to need more investment in fixtures and fittings, which meant more embedded energy than low rise. Last but not least, the intensified high-rise development is likely to form less desirable residential environment. High-rise housing is strongly related with urban heat island and wind tunnel effects, which have negative impacts on the indoor and outdoor living environment (Bálas 1989, Giridharan, Lau et al. 2007, Chen 2008). Taller buildings would influence the day lighting infiltration and ventilation of both themselves and other buildings (Thomas and Cousins 1996). Moreover, residents are forced to share the communal spaces with strangers, and the collective living types could result in conflicts as the lifestyle may diversify (Yuen 2011). There are other problems such as noise, pollution, loss of identity, overcrowding and reduction in privacy that world effect the liveability of high-rise housing (Williams 2000).

Despite conflicting views, national and local policies and discussion documents have increasingly advocated higher residential densities in urban and, in particular, inner urban areas. In the developed countries, especially in Europe, North America and Australia, the third generation of high-rise housing estates began to be constructed as a sustainable housing solution, and most of them provide a higher quality of environment (better and more luxurious), attractive locations (closer to the city centre, the railway station, park or riverside), and a featured image (diverse and distinctive housing design), which are largely being built by the private sector in prime urban location (Turkington, Kempen et al. 2004). They pay more attention to the needs of residents who are usually a special group, such as students, fashion white-collar workers or wealthy elderly, which not only depend on the conclusions of previous empirical studies on outcomes of high-rise living, but also is based on the people’s active selection because of their diversity of housing type options that can satisfy the demands of different family types. On the contrary, in the cities with a large population and limited land such as Hong Kong and Singapore, where there are less housing options for the majority of families, they depend on the comprehensively planning, people-oriented design, high-quality construction, maintenance and management, in order to achieve the sustainable development and construct the liveable residential environment that would satisfy the various needs of all kinds of families, support high-quality living, and continue to be improved through life cycle. In the distinct context, the two different approaches to developing high-rise housing have been practiced.

Above all, as Yeh and Yuen (2011, p3) argued, 'whatever the desire, a change is happening: living in flats may and could increasingly become an urban norm for many people in cities in the coming decades.' More importantly, the residents living in high-rise housing began to participate in the whole process, and their opinions and experiences have gradually become an important basis for housing development in many countries. Faced with this trend, it is inevitable that user-cantered housing research is becoming the mainstream, and how to provide residents with liveable high-rise residential environment becomes one of important issues. The following section will summarize the existing findings and analysis on the current research status, in order to construct the conceptual framework of liveability of high-rise housing estate for this research.

2.4 Contemporary controversy: liveability issues of high-rise housing

As mentioned in Section 2.3.5, although high-rise housing has been widely accepted as a sustainable housing solution, there have been on-going debates on the liveability of high-rise housing. Some scholars believed that the liveability problems were one of the fundamental reasons behind the decline of high-rise housing estates in developed countries in the mid-1970s (Power 1997, Turkington, Kempen et al. 2004). Many commentators assert that, while high-rise housing development does indeed provide substantial benefits and contribute towards sustainable urban development, it is unclear whether the benefits outweigh the negative effects on individuals' quality of life (McLaren 1992, Jenks, Burton et al. 1996, Masnavi 1999, Pank, Girardet et al. 2002, Wener and Carmalt 2006). Disregard of the relative importance between liveability and sustainability of high-rise housing, it is an undeniable fact that liveability of high-rise housing has been continuously questioned and debated.

Based on a review on the existing studies, the following section will first analyse the research designs and approaches widely used in the field of liveability of high-rise housing; and then the findings on liveability of high-rise housing will be summarized from the three terms of negative and positive impacts on residents, and the moderators that serve to mediate those impacts; finally, the current research status and gaps will be revealed.

2.4.1 Research strategies and tactics: empirical studies based on residents' experience and evaluation of high-rise residential environment

Research is designed and carried out in order to test, analyse and amend theory that 'draws from philosophical underpinnings…, and posits specific explanations about something in nature or the social/culture world' (Groat and Wang 2002). Through the analysis of the existing studies, it can be found that there are three research strategies that have been used in liveability research of high-rise housing: correlational research, experimental research and case study research.

1. Correlational research

Correlation research is a research design that aims to discover relationships between two or more variables. It is useful 'because it recognizes that there are many instances in the "real world" where explanatory value can be obtained by showing that certain variables have strong relationships with other variables, without the need to demonstrate that one variable cause another' (Groat and Wang 2002). Among high-rise housing studies, one well-known example is the Oscar Newman's study of high-rise versus low-rise public housing in New York City, which was summarized in his book *Defensible Space* (1972). Newman discovered that there is a significant relationship between the height of buildings and the crime rate in his comparison between high-rise public housing developments and low-rise public housing developments, which revealed the correlation between a formal variable (height of buildings) and a sociological variable (rate of crime). There are many other research instances that seek to find the relationships among different variables, such as high-rise housing and mental health (Gillis 1977, Freeman 1993), outer spaces of high-rise housing estates and residents' social interaction (Holman 1976, Huang 2006). However, these studies that focus on the correlations among several predetermined key elements have an important shortcoming, that is: there may well be other hidden elements that can explain the correlations but has not been considered (Groat and Wang 2002). Therefore, to understand the liveability of high-rise housing need a more comprehensive and complicated model that includes more potential variables.

At the tactical level, data collections of correlation research mainly depend on surveys and observation. Questionnaire survey on satisfaction, preference and perception is the most frequently employed, and it can help researchers to cover a broad range of information across a large number of people in a limited time scale (Marans 1987). In order to compensate for the limitations of this approach and obtain in-depth information, questionnaire is usually used to combine with interview. Another tactic for data collection is various forms of observation. For instance, the research on anti-social behaviours in high-rise housing observed the amount and distribution of different social problems such as graffiti, damage, and litter in various formal public spaces, in order to find the correlations between high-rise residential environmental features and residents' behaviours (Yaran 2008). Another research focused on the relationship between high-rise housing and social interaction among residents through investigating the frequency and manner of people's communications (Huang 2006).

2. Experimental research

Experimental research focuses on the causal connections between two or more variables. Based on a controlled setting, the impact of one variable's behaviour on other variables is observed, and certain conclusions are reached from these observations. Different from correlation design that assumes the researcher simply measures the variables of interest and analyses the relations among them, experimental design depends on the researcher's active intervention. In the field of high-rise housing research, experimental research has not only been used to test the building technologies to improve high-rise residential environment such as thermal comfort (Dear and Leow 1990, Bojic, Yik et al. 2001), wind environment (Jones, Alexander et al. 2004, Wang, Liu et al. 2007), but also to investigate the impacts of high-rise residential environment on residents such as height of floor on residents' sense of space (Schiffenbauer 1979), high-rise building on suicidal impulse (Clarke and Lester 1989).

Tactically, experimental research mainly involves three terms of tactics: experimental setting, treatment and outcome measures. As Groat and Wang (2002) summarized, 'the experimental setting can range from a highly controlled laboratory to less well-controlled field site; the treatment conditions can range from highly calibrated physical manipulations to categorical, nonphysical condition; measurement of outcome variables can range from the precise calibration of a physical change to the more descriptive index of a behavioural response.' However, the tactics of experimental research resulted that the research outcomes and findings were always questioned due to the reduction of complex causality reality to identify 'causal' or independent variables (Penn 2008).

3. Case study research

Case study research can be seen as a conceptual container that can contain other research approaches (Groat and Wang 2002). From the perspective of existing research, mainly three types of case study research have been used to measure the impacts of high-rise residential environment on residents. The first one is to examine certain outcomes (e.g. satisfaction, social interaction, mental health or impact on children) in one or more study cases of high-rise housing (e.g., Yeh and L.Tan 1974/75, Williamson 1981, Korte and Huismans 1983, Huang 2006), and some studies considered the moderating elements such as respondents' personal characteristics and the contextual features (e.g., Young 1976, Ginsberg and Churchman 1985, Yeh and Yuen 2011). The second method is to compare the outcomes between high-rise living and low-rise living, and discusses the influence of the potential moderators (e.g., N/A 1964, Holahan and Wilcox 1979, McCarthy, Byrne et al. 1985). In theory, the more cases in the sample, the better chance that the significant variations in the planning, design, construction, neighbourhood, life-stage, or level of maintenance and management among the high-rise housings and among the low rise housings that influence the liveability, can be found. Meanwhile, the impact of variations of immediate interest can be effectively weakened or even excluded, and will not change the results. Moreover, it was found that random assignment was the best form of sample selection , with better control over the key or independent variables, which can make the research much closer to the ideal situation (Gifford 2002). In the third type of research design, researchers observe the outcomes of a group of residents through a long time scale, which can assess changes in the same group of subjects living in high-rise and other housing types and help to find the long-term effects on residents in the residential environment (e.g., Appold and Yuen

2007, Aratani 2010). This type of research design can be used in conjunction with one of the previously-discussed research methods. However, this design could have some disadvantages, such as not always being able to ensure that the observed changes in the residents are caused by the specific elements other than the high-rise building form *per se* (Gifford 2007).

As Gifford (2007) concluded, it is very difficult to carry out a housing study that meets standard criteria for scientific hypothesis testing, thus in most cases, 'researchers are forced to use non-optimal research design'. Despite the fact that each type of research design has respective advantages and disadvantages, when different methods are employed and similar results are found, conclusions based on these results could be more convictive (Groat and Wang 2002). Meanwhile, when a great number of imperfect studies came to similar conclusions, the replication of conclusions is a strong support to themselves. Based on the above acknowledgement, despite the lack of mature theory and model, the existing findings on liveability of high-rise housing obtain some degree of theoretical support. The following sections will reveal the liveability issues of high-rise housing in three aspects: disadvantages, advantages and moderators.

2.4.2 Liveability weaknesses of high-rise housing: residents' negative experiences

Since the 1950s, the social, physical and psychological effects of high-rise living on residents have become focus issues (e.g., Kennedy 1950, Bauer 1952, Wilner, Walkley et al. 1956). With the mass construction of high-rise housing estates in 1960s and the emergence of many problems, more researchers started to discuss and research consequences of high-rise living. Many studies indicated that high-rise housing cause many unpleasant outcomes. Some researchers suggested that high-rise housing could result in social problems, such as the decline of social security, the destruction of community and neighbourhoods (e.g., Ginsberg and Churchman 1985, Turkington, Kempen et al. 2004, Costello 2005). Other scholars concluded that high-rise housing could lead to such physical and psychological problems as sense of fear, stress, behaviour problems, suicide, poor social relations, reduction of helpfulness, and hindering child development (e.g., Gillis 1977, Fuerst and Petty 1991, Gifford 2007).

The following will summarize the relevant findings.

1. Health problems of high-rise residents

The World Health Organisation (WHO) defined health as 'the level of functional and (or) metabolic efficiency of a living being, … a state of complete physical, mental and social well-being' (Evans, Chen et al. 2006). Lots of studies on high-rise housing indicated that high-rise living has negative impacts on residents' health. According to a recent survey conducted by GoWell (2011) in the UK, the authors concluded that high-rise living can lead to more respiratory problems, headaches and short illness episodes, sometimes referred to as 'sick building syndrome'. The study discovered that mental health indicators of the residents living in high-rise housing have been worse, and uses of doctors for psychological reasons have become higher among the residents living in high-rise housing. And a number of causal pathways for these outcomes have been identified including: being unable to avoid the habits of others in close proximity; feeling isolated in tall buildings; and distancing from the restorative effects of natural settings and views (GoWell 2011). Some studies reported that some form of strain associated with high-rise living. For instance, McCarthy and Saegett (1978) found that high-rise residents felt more crowded and reported a lower sense of control and less social support than low-rise residents. Other studies claimed that high-rise living was more likely to result in the strain of crowding, and even make the relationships among neighbours worsen (Schiffenbauer 1979, Bordas-Astudillo, Moch et al. 2003). Another research indicated that the residents who lived in multiple-family units on higher floor had greater emotional strain (Mitchell 1971). Some researchers discussed that certain mental illness, such as depressive symptoms and psychological symptoms, were related with the building height. In two English studies, Goodman (1974) and Richman (1974) detected that the rates of mental illness increased with floor level. similar result was reported by other researchers such as Hannay (1981), Cappon (1971) and Freeman (1993). Littlewood and Tinker (1981) discovered that the residents reported fewer symptoms of depression when they moved out of high-rise housing.

2. Lack of safety

Safety is denoted as one of the fundamental issues that the liveable environment should have. However, because high-rise housing is a distinct residential form that most people are living off the ground, so there are some special safety problems. As summarized by Gifford (2007), high-rise residences easily evoke the sense of fear and unsafe, such as *fire, natural disaster* (earthquake), *communicable diseases* and *failures of the infrastructures* (lift, water and electricity supply), even attack like 911. Marks (1969) found that people with certain kinds of phobia have fear of high-rise and feel unsafe. Haber (1977) observed that his respondents want to live in the lower floors of high-rise buildings due to the fear of fire and elevator failure. Moreover, the fear of disease transmission in the high-rise residential blocks, such as the Severe Acute Respiratory Syndrome (SARS) outbreak in Hong Kong in 2003, has been highlighted as an important element (Hung, Chan et al. 2006). Although these physical issues on fire and elevator can be improved or resolved by technological methods, the dwellers' sense of fear could not be completely eliminated, which not only relate to their residential environmental elements, but also to their individual characteristics and the contexts where they live (Wong 2011). Therefore, it is necessary to understand the relationship between the dwellers' sense of safety and the residential environment of high-rise housing in a comprehensive model including the potential moderators.

3. *Poor public security*

Public security is one of the most important elements that impact liveability of residential environment. In fact, the security of high-rise housing was one of the main problems questioned and criticized by scholars. Generally speaking, the sense of insecurity in high-rise housing is caused by high crime rate and anti-social behaviours, such as vandalism and graffiti. More importantly, according to the theory of Housing Dynamics, these elements together lead to the "*filtering down effect*", which could result in poverty concentration and form new urban slums (Bier 2001). Behind these phenomena, both poor social environment and defenceless physical environment are the main reasons.

As the history showed, the early high-rise housing estates were wildly accepted as the modern, efficient solution to house working-class families, which led to the excessive concentration of low-income families in these estates (Beedle 1977). When the option was available, people began to 'vote with their feet' to be replaced by those with less choice, which further deteriorated the social environment and formed a vicious circle. To address this issue, many researchers have given useful suggestions in terms of *housing policy* and *management*. For example, Power (1976, 1993, 1997, 1999) have analysed the decline and rescue of twenty public housing estates in five European countries and claimed that social mixture and tighter management control should be effective approaches to improve the social environment of high-rise housing estates. And many studies on the regeneration of post-war high-rise housing estates in developed countries have come to similar conclusions (e.g., Ingar and Thorbjørn 2004, Costello 2005, Hugo 2006).

On the other hand, compared with low-rise housing, there are some specific physical features of high-rise housing, such as more collective spaces and facilities in and around high-rise housing that cannot be effectively monitored by residents, and if these spaces cannot be effectively *managed* and *maintained* by the responsible agencies and companies, they could become potential areas for abuse – litter, graffiti and crime. According to Newman's (1975) findings, crime-rate at high-rise estates was significant higher than that of mid-rise housing, and crimes occur at high rate on the outside grounds of high-rise building and at much higher rate in the interior semi-public spaces. Both Oscar Newman (1972, 1996) and Cooper Marcus and Hogue (1976) suggested the reinforcement of planning and design of high-rise housing estates -- clear boundary of the site, monitored entry to the estate and buildings, identifiable clusters of buildings -- to encourage a strong sense of surveillance from each dwelling unit. In practice, some of high-rise housing estates have been relatively more successful due to their gated community management and building access control (Fuerst and Petty 1991, Turkington, Kempen et al. 2004, Shaftoe 2007). Above all, security problems of high-rise housing, such as levels of crime, vandalism and other 'environmental incivilities' have been associated with a number of physical design characteristics such as *building height*, *block size*, *extent of shared space*, and *number of entrances and exits from buildings* (GoWell 2011).

4. Weakening social relations

A lot of studies indicated that high-rise housing influence resident's social relations in two main domains: *relations with neighbours, sense of community and neighbourhood*. For the former, Jephcott (1971) in his research on high-rise housing estates in

Glasgow found that high-rise flat '*isolates people with each other' and 'is a sealed cell and the people on one floor know far less above or below them than would be the case were they in neighbouring houses in a street'*. The findings of both Stevenson, Martin and Neill (1968) and Korte and Huismans (1983) showed similar results: comparing with low-rise housing, the high-rise residents have poorer relationships with their neighbours. Although high-rise dwellers have more neighbours live in the same building and have more residential acquaintances, they have less close relations and interactions with them than their low-rise counterparts (Williamson 1978, Holahan and Wilcox 1979, Churchman and Ginsberg 1984). Moreover, some studies detected that both outdoor socializing in high-rise housing estates and indoor social interactions such as in the lift hall were at lower levels than that in low-rise housing, but this can be improved by setting up places and facilities designed to encourage social interaction (Holman 1976, Givoni 1991, Huang 2006). Nevertheless, generally speaking, high-rise occupants have been found to have less familiarity with neighbours and lower levels of social support than other people, which has been variously attributed to the effects of high turnover of residents in high-rise, the deterioration of public space on estates, and the inability to regulate social interaction, which causes people to socially withdraw (GoWell 2011). Because high-rise housing discourages social interaction in the estates, so the sense of community is inevitably weakened. Some studies discovered that high-rise dwellers tended to make friends with colleagues or schoolmates living in the same area, which resulted in weak sense of community and relatively strong sense of neighbourhood (Michelson 1977, Forrest, La Grange et al. 2002). The low level of sense of community including sense of belonging and identity, will eventually influence the residents' quality of life, so the conditions of social relations in high-rise housing estates are significant elements in respect of their liveability. However, the poor social relations may associate with some complicated results such as greater privacy and freedom from unwanted social interaction, and less intimate social interaction and less caring about anonymous others, which are influenced by some moderators such as gender, age and life-stage (Gifford 2007).

5. Negative impact on families with younger children

Some early debates on high-rise housing's liveability focused on the impact over the families with younger children. In USA, Bauer (1952) claimed in his article, that 'almost universally, families with growing children apparently want to live at ground level'. And then, a set of studies in Sweden, Britain and Denmark came to the similar conclusion that there were some negative impacts on the families with children in high-rise housing (Sandels and Wohlin 1960, Sheppard 1964, Morville 1969a, Morville 1969b). In most cases, negative effects upon families of living in high-rise has been found to include heightened family conflict, parental isolation, and behavioural and development difficulties among children. Some of these effects are the result of parents keeping their children indoors due to concerns about not being able to supervise them in a high-rise environment. In fact, children's outdoor play areas were the significant distinction between high-rise housing and garden house. In the majority of high-rise housing estates, there are only public (in open communities) and semi-public (in gated communities) play areas and most of them are out of parents' supervision.

Further researches indicated that parents and children are influenced in different ways by the lack of play areas for children. From the perspective of the child, the problems mainly concentrated on everyday activities, especially play and communication. Studies showed that residence on upper floors of high-rise buildings is often associated with lower physical activity, behavioural problems, and respiratory illnesses in children, and with neuroticism and social isolation in stay-at-home mothers and military wives. Restricted to outdoor play without supervision may be the key element in these adverse health effects. Some researchers found that children from high blocks start playing out of doors on their own at a later age than children from low blocks, as well as having fewer contacts with playmates than those in low blocks (Morville 1969b, Leventhal and Newman 2010). Moreover, the play areas are always out of parents' sight, which can result in children's under-supervision in an outdoor environment and over-protection in an indoor environment (Currie and Yelowitz 2000, Gifford 2007). From the parents' perspective, raising children in high-rise, especially on higher floors, is problematic. Mitchell (1971) claimed that high-rise living can cause pressure on parents due to the lack of safe and adequate play areas for children. Especially when these children are playing at ground level space, they are normally unable to communicate with their parents, which interrupt parent-child visual and auditory contact. Meanwhile, the lack of communication can lead to the reduction of parent's knowledge of and control over children (Fincher 2004, Yuen 2011). In a study in the UK, more depressive symptoms were reported by mothers who lived in flats than those who lived in houses (Richman 1974). Social isolation of mothers and restricted play opportunities for children are suspected reasons for the links between high-rise living and psychological distress. Often in high-rise buildings, insufficient resources are allotted to spaces that allow for the development and maintenance of social networks (i.e. lobbies and lounges). Often women report loneliness in high-rise buildings, and parents often keep young children inside in larger multi-unit dwellings. These restrictions heighten interfamilial conflict, minimise play opportunities and remove the ability of neighbourly interaction (Evans, Wells et al. 2003).

However, it is not said that high-rise housing is unsuitable for such groups. In certain situations, such as Singapore and Hong Kong, high-rise housing is the only alternative available for the majority of families. On the one hand, the long-time living in high-rise housing increases people's ability to adapt to the residential environment. According to the reports of Yeh and Yuen (2011), and Appold and Yuen (2007), the new generation families with children have accepted and enjoyed high-rise living, and they even wanted to move to higher floors. On the other hand, the targeted planning and design improved the safety of public space and offered children better play areas. Cooper Marcus and Hogue (1976) have given some suggestions on play-areas' planning and design to improve high-rise housing' liveability for children. Similarly, in Singapore, high-rise housing blocks have the void decks at ground level that is an internal public space for senior citizens and children, and the concrete space between residential buildings include roof space are landscaped as green spaces, gardens and outdoor play areas for children and other residents. The study about the residential environment of high-rise housing in Singapore indicated that these methods have achieved good results (Yuen 2011). So it can be concluded that the planning and design of *play areas* is an important element to improve the liveability of high-rise housing for families with children.

2.4.3 Liveability strengths of high-rise housing: residents' positive experiences

From the viewpoint of residents, high-rise living is not without its attractiveness. For example, some studies have found that more open space between high-rise blocks can help to form a space transition from public, semi-public, semi-private to private, which can give more *privacy* and *space* to residents, and can facilitate casual and social contacts among residents (e.g., Conway and Adams 1977, Churchman and Ginsberg 1984, Huang 2006). Large-scale public and semi-public spaces usually provide residents with high-quality and well-maintained *public green areas* around their buildings in high-density inner-city, which is indeed very attractive for the people living in the busy cities (Yuen 2011). Other researchers have discussed that high-rise living could give the residents spectacular *view* and *quietness* (e.g., Roeloffzen, Lanting et al. 2004, Appold and Yuen 2007, Jim and Chen 2010). For instance, Benson and Hansen (1998) suggested that high-rise living is valued for the spectacular views and sensation of height. Haber (1977) found that more women are attracted by the view while more men are attracted by the feeling of height. And the feelings of prestige and status is often associated with high floor living. Some studies discovered that the value of high-rise housing has significant relationship with the view and height of floor (Jim and Chen 2009, Jim and Chen 2010, Tang and Yiu 2010).

Moreover, the lifestyle itself associated with high-rise living may attract some specific groups, such as young professionals, childless couples, empty nesters and high-income earners. In the research of residential satisfaction, certain demographic groups are more likely to be satisfied with high-rise living. A study in Chicago indicated that childless couples and young singles are more adaptable to high-rise living and express higher satisfaction (Wekerle and Hall 1972). The main reason is that they can spend more time on their social lives and do not need to spend time for gardening, which is very suitable for their lifestyle. Another research in New York suggested that those rich residents who live in good neighbourhoods and newest luxury estates have high satisfaction with high-rise apartments (Mackintosh 1982). Some researchers such as Newman (1975) believed that high-rise housing should be suitable for the elderly people, because of freedom from gardening work and safety within a large building. A research of the elderly who were randomly assigned to high- and low-rise apartments, reported a little more preference to high-rise than low-rise (Duffy and Willson 1985). However, some studies have had opposite conclusions (e.g., Wekerle and Hall 1972, Zaff and Devlin 1998). For example, Zaff and Devlin (1998) found that the elderly residents of garden apartments have greater sense of community, and have less chance to have self-disclosure than those of high-rise apartments. In another research, despite of the similar overall satisfaction, aged residents living in low-rise were satisfied with their closeness to nature, while those living in high-rise were happy with the social life in the buildings (Devlin 1980). The findings indicate that residential environment should match residents' characteristics and preference in order to maximize residential satisfaction.

As mentioned in Section 2.3.5, the rebirth of high-rise housing estates in Western world was benefited from these study findings, which promoted the generation of a new high-rise housing development model that focus on the specific consumer groups and select the attractive location such as convenience city centre or suburbs with fantastic landscape (Turkington, Kempen et al. 2004). Some authors have noticed the phenomenon that developers build high-rise apartments in city centre for the purposed consumer such as 'empty nester', or 'young professional', which result in the lack of facilities for children in the precincts where similar high-rise housing estates concentrated in (see: Fincher 2004, Turkington, Kempen et al. 2004, Costello 2005). These researches and practices all above suggest that the liveability of high-rise residential environment needs to take full account of the moderating elements such as residents' characteristics and the specific context.

2.4.4 Moderating elements: macro-context features and residents' demographic characteristics

As the arguments on the liveability of high-rise housing illustrated, different residential environment have different disadvantages and advantages for different residents in different contexts. In other words, different residents could have different concerns on their respective high-rise residential environments in different time. Some elements, called *moderators*, are independent of the high-rise residential environment *per se* and may moderate the residents' experiences of high-rise living (Gifford 2007). These moderators are elements 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). Therefore, the research on liveability of high-rise housing need to not only analyse the relationship between residents' evaluation and their residential environments, but also understand the impacts of the moderators including residents' demographical characteristics and the contextual features, which is indispensable for understanding and interpreting the liveability of high-rise housing estate. These elements are presumed to moderate the negative and positive outcomes of residents in conjunction with high-rise residential environment.

The first group of moderators is the features of macro-context, such as ***availability of choice among different housing types, housing culture and history, climate, economy and society***. The broader background such as housing system, market, culture and history also have important implications, which have great significance for understanding the liveability of high-rise housing (Yuen, Yeh et al. 2006). In the comparison of Western and Eastern urban housing, some researchers found the residents have higher overall acceptability and satisfaction with high-rise living in Hong Kong and Singapore than in the UK, USA and Australia, which could be explained by the differences of culture, climate and the availability of choice among different housing types (Yeung 1977, Yuen 2005, Yeh and Yuen 2011). Moreover, the level of economic and social development can mediate the perception of residents on the liveability of high-rise housing. For example, the increase of income levels and the construction of new high-rise housing could result in the changes in assessments of the existing high-rise housing (Williamson 1978, Ornstein, Villa et al. 2010). To sum up, the macro-context not only shapes the residential environment of high-rise housing estates, but also forms the residents' living habits and housing preferences, which can impact residents' perception of liveable residential environment, and further influence their experience and liveability evaluation. Therefore, the liveability research should be based on the analysis of the specific context.

The second group of moderators is residents' demographic characteristics, including six indices: ***gender, age, degree of education, family income, life stage and household size***. Many studies indicated that certain demographic groups, such as young mobile singles, childless couples, and the elderly, could be more suitable for high-rise living (e.g., Jephcott 1971, Wekerle and Hall 1972, Richman 1974, Newman 1975, Conway and Adams 1977, Marmot 1983, McCarthy, Byrne et al. 1985, Joseph 2008). For example, Cappon (1971) explored that some elements, such as residents' life-cycle stage and gender, moderated the impacts on their mental health despite all of them living in high-rise buildings. And McCarthy (1985) in his research on the relationships among housing type, housing location and mental health, took into account of the effect of age, sex and household class as well. Another study conducted by Mackintosh (1982) found that high-rise living attracted more families with employed women and people who had grown up in high-rise housing. Moreover, some researchers concluded that among high-rise dwellers, the wealthier residents living in tall expensive buildings in desirable locations are more satisfied with their high-rise housing than the low-income residents in public high-rise dwellings, which not only showed that economic status could influence the residents' high-rise living experience, but also proved that living context may moderate the impact of high-rise housing (e.g., Turkington, Kempen et al. 2004, Fincher 2007, Joseph 2008, Mohit, Ibrahim et al. 2010, Ornstein, Villa et al. 2010).

2.4.5 Research gaps: the lack of a resident-centred theoretical framework and the scarcity of research in the context of China

According to the review of the previous studies, there are at least two research gaps in the field of liveability of high-rise housing. The first gap is the lack of a resident-centred theoretical framework of liveability of residential environment. Due to 'the difficulties of measuring human behaviour and the limitations of conventional social science research in the practical context of planning, designing, building, managing and occupying buildings' (Vischer 2008, p232), none of a widely accepted theoretical model of liveability has been established (Howley 2010, Leby and Hashim 2010, Whelan 2012). Especially for high-rise housing estates, there is no unified method or standard for the measurement of liveability. The majority of the existing studies focused on the relationships between respondents' demographic features (such as gender, age, degree of education, and income), certain high-rise residential environment features (such as building form, height and density) and specific liveability issues (such as health, safety, security and social relation) from the various disciplinary perspectives (such as environmental psychology, behavioural psychology, and sociology), which resulted in two consequences: on the one hand, as Robert Gifford pointed, 'the literature remain a shapeless morass of almost bivariate relations' (2007), and the existing research findings cannot effectively service the practical needs; on the other hand, the reliability of the existing research results have constantly been questioned due to the flaws of research design, for example, Oscar Newman's 'Defensible Space Theory' suggested that the spatial features of high-rise dwelling buildings caused the decline of safety and security, but more evidences indicated that the excessive concentration of low-income families in public high-rise housings could be the more significant reason rather than the high-rise residential environment (Perkins, Florin et al. 1990, Frank 2004). Therefore, it is necessary to establish a research framework that can integrate the existing findings, while being based on the residential environmental features of high-rise housing estates.

The second gap is the omission of study on liveability of high-rise housing in the context of China. As the existing research showed, the understanding of liveability of high-rise housing estates should not only be based on residents' experience and satisfaction, but also should fully consider the impacts of moderating elements--residents' personal demographic characteristics and features of macro-context. An obvious example is the significant difference of residents' satisfaction and acceptance to high-rise public housing between the UK and Singapore. More than 80% of Singapore's 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: Yuen, Yeh et al. 2006, GoWell 2011). This phenomenon has led to the recognition that liveability research needs to focus 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). Meanwhile, many studies have indicated that resident's experience and satisfaction could be influenced by the demographic features of respondents, such as gender, age, income, degree of education, household size and life stage (Amerigo and Aragones 1997, Adriaanse 2007). Moreover, researchers discovered that it is through the combination and comparison of the findings of numerous empirical studies in various contexts that the liveability of high-rise housing estates can be further understood and revealed (Rosenthal 1991, Gifford 2007). However, the majority of liveability studies on high-rise housing focused on the developed areas such as Europe, America, Australia, Japan, Hong Kong and Singapore. China, with its distinctive context and the rapid development of high-rise housing, has not been fully researched in the past decades.

2.5 Design response: liveability elements of high-rise housing estate

As the above section showed, many studies indicated that there indeed exists an inherent contradiction between liveability and high-rise housing, where the majority of residents are living in high-density and off-ground residential environments. One of the root causes of many liveability problems is the conflict of interests between 'environment users' and 'environment creators' and the lack of understanding on the users' demands and experiences. From the perspective of housing planning and design, the basic value – the provision of liveable residential environment within the bounds of economy – do not change over time (Glendinning and Muthesius 1994). However, the large-scale industrial development of housing estates weakened the linkage between architects and residents, while the profit-oriented housing development promoted the design and planning of high-rise housing estates to aim to build the residential environment that meet the standardized and the minimal/optimal demand, especially under the limitation of cost. Some studies, such as Alice Coleman's study 'Utopia on Trial' (1985), suggested that architects and planners should take inescapable responsibility for those problematic high-rise housing estates in 1960s and 1970s.

The existing studies on the liveability of high-rise housing lacked a comprehensive liveability evaluation model that was able to effectively communicate residents and professionals, especially planners and architects. In fact, as the definition of high-rise housing estate showed in Section 2.2.2, it is composed of the four spatial levels – *dwelling unit*, *dwelling building*, *housing estate* and *urban neighbourhood*, which form the fundamental residential environment components of high-rise housing estates. The four spatial levels not only correspond to residents' environmental cognition from home, house, community, to neighbourhood, but also cover the professional fields from interior design, architecture design, landscape design, regulatory plan, urban design, to urban planning. Meanwhile, the residential environments of high-rise housing estates include the psycho-social and physical dimensions to meet the residents' living demands. Combined together, a conceptual model of residential environment of high-rise housing estates can be established

(Figure 2-16). Based on the model, through reviewing the related studies and experiences, the liveability elements of high-rise residential environment will be summarized at the four spatial levels. Finally, a liveability evaluation model of high-rise housing estates will be developed to guide the whole study.

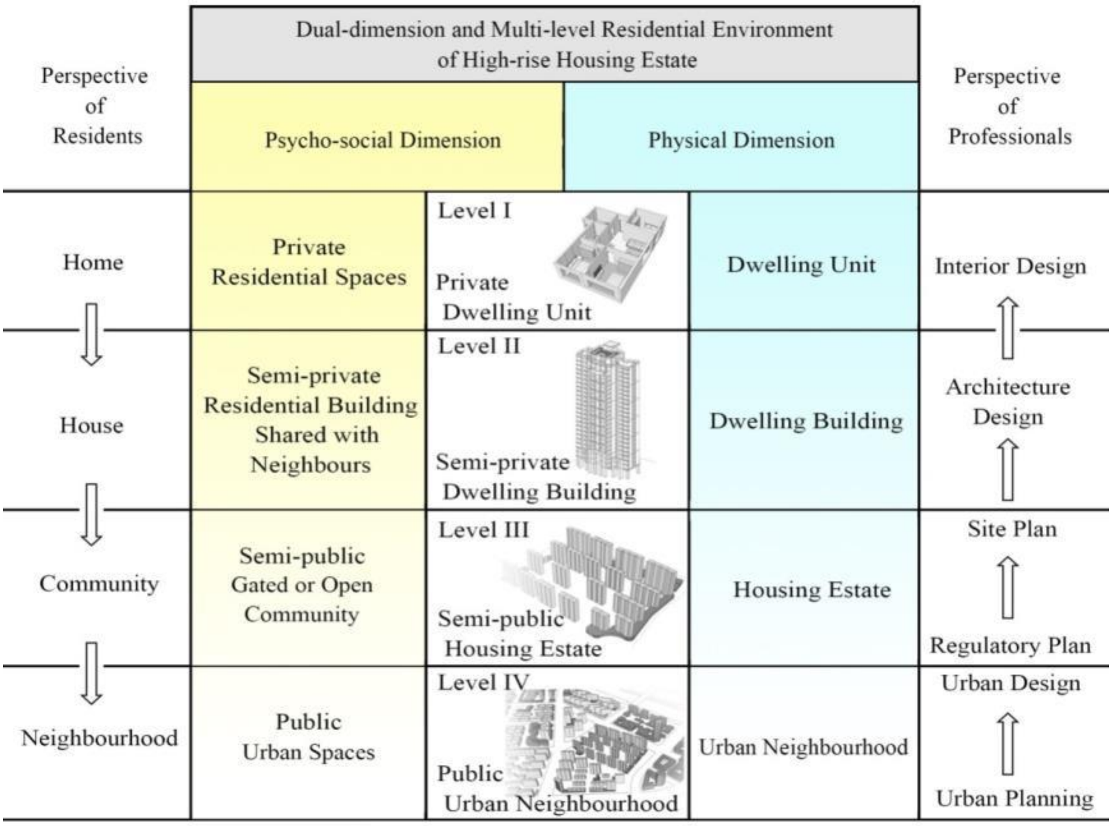


Figure 2- 16 Conceptual Model of Residential Environment of the high-rise housing estate

As has been analyzed in Section 2.4.4, based on the existing studies on the outcomes of high-rise living, there are two groups of elements that could moderate the liveability evaluation of high-rise housing estates, i.e. **macro-context features** and **residents' demographic characteristics**. The conceptual model of the residential environment of high-rise housing estates can directly connect to both the macro-contextual elements including ***housing market*** (availability of choice among different housing types)***, housing culture and history, environment*** (urban land and structure)***, climate, economy and society***, and the micro-personal elements including ***gender, age, degree of education, family income, life stage and household size***.

On the one hand, the macro-context directly shapes the professional system consisting of urban planning, urban design, landscape design, architecture design and interior design, which collectively decide the form of the residential environment. On the other hand, demographic features have not only impacts on the resident's housing choice and adjustment, but also influence their acceptation of and adaptation to high-rise living, which could affect their experience and evaluation of high-rise residential environment. As a consequence, the residential environment features can reflect the residents' personal attributes. More importantly, the structure of the conceptual model of high-rise housing estate (Figure 2-16), can more accurately describe the connections between residential environment features and macro-context and residents' personal attributes.

2.5.1 Dwelling Unit: the liveable private spaces

Size, layout and storage

Size and layout are two important liveability elements of the dwelling unit: one is about the adequacy of living space, and the other is about the function of living space. Due to higher construction cost of high-rise housing, compact and standardized design of dwelling unit becomes a rational choice. However, the size of the dwelling is related with crowding, occupancy and privacy, which have both mental and physical health effects on residents. For example, overcrowding could result in greater stress and worse relationships among residents (Gifford 2002). People often feel cramped in smaller dwellings as there is not enough room to carry out daily tasks comfortably, which can lead to dissatisfaction and distress which may lead to lowered physical health (Lyne and Moore 2004). Layout of dwelling unit has significant influences on residents' daily life. Having reviewed the evolution of the layout of high-rise housing, it can be found that the layout experienced a change from a large living-room with a minimal 'working kitchen', to a large living room with a large 'working kitchen' for occasional meals, to a smaller living room with a larger 'dining kitchen' or a living room with a dining recess, and now the 'open plan' with a large 'through' living-dining-kitchen room, which associated with the changes of residents' demand and lifestyle (Glendinning and Muthesius 1994).

Storage is a very important but often overlooked element in high-rise housing. The diversity of demand on storage space in different family types make it difficult to establish a standard, a result of which is that it is always sacrificed under the strict budget. However, studies indicated that the adequacy of storage could affect the amount of space that people have to carry out day-to-day tasks (Minami 2007, Lee and Park 2011). This is also a safety and hazard issue for physical safety and health as objects which cannot be stored elsewhere can become hazards in daily life and emergencies (Bennett 2010).

Structure quality

Structure quality is a liveability element that is often mentioned in the literature on high-rise housing. Design and construction of high-rise housing are more complicated, the development scales are usually larger, and the cost control is stricter than that of low-rise housing types, which bring more challenges to the control of structure quality. Because of high construction difficulty and complexity, it is prone to a variety of quality problems. Once there are problems, repair and maintenance costs would be much higher than other housing types. In fact, poor structure quality of dwelling units is associated with health and safety issues. For instance, poor waterproof of roof and windows result in dampness and cold that are the most common health hazards of poor structure quality. Bumps and cracks in walls and ceilings influence the residents' safety and satisfaction with their residential environment (see: Yeh and L.Tan 1974/75, Liu 1999, Kazaz and Birgonul 2005, Wong 2011). Other structure problems, such as French windows without safe fence, exposed heating sources and faulty wiring, could influence the liveability of high-rise housing.

Infrastructure of dwelling unit

The infrastructure system of high-rise housing is directly related with residents' essential living needs, and is a necessity for the liveable residential environment. For example, water supply system is very important for high-rise living. Studies indicated that poor water filtering systems can lead to bacteria growth and infections such as Legionnaires disease –a severe type of pneumonia (Raw, Aizlewood et al. 2001). For high-rise housing, water supply system consists of domestic water supply and fire water supply. Because the height of high-rise housing exceeds the height of municipal water supply network, the secondary pressurized water supply system must be used which increase the risk of water contamination in pressure system. Moreover, adequate drainage is required to ensure the removal of grey and black water and no resulting infectious diseases being transmitted. In certain situations, drainage system includes the separated drainpipes for rain water and air conditioning condensation water. Inadequate toilet and sanitary facilities can result in the transmission of harmful bacteria and diseases such as SARS (Hung, Chan et al. 2006). Electricity system of high-rise housing is more complex, and includes domestic electricity and public facilities' electricity such as public lighting and lift. Therefore, the backup power supply system must be equipped in order to respond to emergency situations such as power failure.

Natural lighting and ventilation

As the history of housing design illustrated, natural lighting inside the dwelling became a significant element for liveable residential environment since the health movement in the nineteenth century (Glendinning and Muthesius 1994). The provision of as much as possible daylight inside the dwelling was emphasized by almost all modern architects. The pursuit of maximized natural lighting not only impacted size, form, position, and even manufacture of windows, but also influenced the buildings orientation, height and form. But more than that, 'daylight was the most onerous of the determinants of estates layout' (Owens 1987). Even, to some extent, daylight shaped many cities and villages. For instance, the traditional Chinese towns were built according to the orientation of North-South so that the majority of buildings can get the most sunlight. In the UK, the 'Daylight Code' was promulgated in 1950 in order to ensure the adequacy of daylight inside dwellings. According to Raw, Aizlewood and Hamilton's report (2001), daylight appears to have special significance both physiologically and psychologically for residents. For example, short daily exposures to natural light throughout the year assure the maintenance of Vitamin D metabolism, and deficiency of Vitamin D can lead to skeletal disorders such as rickets in children and osteomalacia in adults (Raw, Aizlewood et al. 2001). Meanwhile, there is an anatomical link between the optic pathway and the pineal gland in the brain. Day-lighting is an element that influences the pineal secretion of melatonin into the blood-stream. Melatonin is thought to influence circadian rhythms, sleeping, and waking and mood states. Seasonal Affective Disorder (SAD), as well as changes in production of adrenal steroids is also thought to be linked to either the intensity of daylight or the spectral quality of light –of which daylight is considered 'the best'.

Air movement and ventilation is also a very important element for residential environment. Effective ventilation can remove indoor air pollutants, improve indoor air quality, and adjust the indoor humidity and temperature (Niu 2004). Inadequate ventilation increases moisture in the home, which contribute to asthma, mould-induced illnesses, carbon monoxide poisoning and so on (Bullen, Kearns et al. 2008). However, while mechanical ventilation system can effectively satisfy the requirement of comfortable residential environment, its energy consumption and potential risk of mechanical failure and negative health effects decided that it cannot completely replace natural ventilation. Especially for high-rise housing, some inherent conditions such as chimney effect, better thermal and wind pressure effect, can effectively improve the ability of natural ventilation.

Natural ventilation and daylight quality within dwelling unit of high-rise housing are determined by many common elements, including building types, layout, the size, number and position of windows, the floor area of space, window floor area ratio, the height and shape of the room, the building footprint shape, external obstructions, building orientation, obstructions caused by neighbouring towers and distance between towers, external barriers to wind and daylight such as hills and internal furniture layouts (Lau, Baharuddin et al. 2006). Some studies found that there could be some contradictions among liveability elements. For example, the transparent glass and open windows can improve the natural daylight and ventilation, but can cause lack of privacy (Lau 2011).

Indoor thermal comfort

Thermal comfort is an important research field, and is a significant element of liveable residential environment. Generally speaking, 18 to 24℃ is considered ‘comfortable’, below 16°C is considered too cold and unhealthy. Outside this range, thermal stress increase progressively, and defence mechanisms such as shivering and sweating come into play (Raw, Aizlewood et al. 2001). In fact, thermal comfort could be influenced by a range of elements, including metabolic rate (activity), clothing (personal insulation), air temperature, radiant temperature of surroundings, rate of air movement and atmospheric humidity (De Dear and Schiller Brager 2001). It is also affected by other elements such as surroundings, location, and even culture (Ruck

1989).

For high-rise residential buildings, the majority of dwelling units are over the height of natural plant, which makes them directly exposed to sunshine and wind. Groups of high-rise buildings can evoke the heat island effect, which will deteriorate the surrounding thermal environment and wind environment (Lau 2011). Meanwhile, those dwelling units on higher floors have to depend on air conditioning system and heating system that consume large amount of energy in order to keep its indoor environment quality, and a large part of energy consumption convert into heat and enter into the surrounding environment. Consequently, the high-rise dwellings need to consume more energy to achieve the indoor environmental comfort, which forms a vicious circle. Therefore, how to use environment-friendly methods to achieve indoor thermal comfort of high-rise housing is an important research topic. In most climate zones, ***cooling in summer*** and ***heating in winter*** are fundamental issues of indoor thermal comfort (De Dear and Schiller Brager 2001).

Indoor air quality

Good, clean air to breathe is very important as there is a wide range of potential air pollutants and a large number of ways that can affect liveability. Depending on the type of pollutant or mixture of pollutants and the length of exposure, physical health, mental health, comfort and well-being can all be affected. In some cases headaches and even death can occur quite rapidly (i.e. carbon monoxide poisoning). The most common air pollutions are carbon dioxide, carbon monoxide, nitrogen oxides, formaldehydes, tobacco smoke, water vapour, airborne allergens, asbestos and other mineral fibres, airborne pathogens, and toxic emissions from polymers and consumer goods (Ranson 1991). Most of these can come from building materials, construction, services & controls, spatial design, occupants, environmental elements and maintenance & management (Singh 1996). According to a study conducted by Lau and Li (2006), when the elevation height of high-rise housing increases from 5 to 40 metres, the age of air reduces, which indicate better ventilation and cleaner air in the upper floors. An analysis on the qualitative data gathered among occupants in high-rise living in Hong Kong supported this conclusion. It was found that the general opinions of occupants preferred the apartments in higher floors due to better air quality and reduced noise levels (Lau 2002).

Noise inside dwelling unit

Noise inside dwellings not only comes from external sources, such as transportation, people, and animals, but also from nearby or adjoining dwellings or buildings, such as elevator equipment noise, neighbours voices or activities. Because of the lack of obstacles to reduce ***external noise***, high-rise housing mainly depends on the ability of sound-proof of windows, which could conflict with the demand of natural ventilation and privacy (Ko 1978). At the same time, due to more public facilities such as lifts, stairs and corridors, and more adjoining walls, floors and ceilings, there are more noise sources in high-rise residential buildings than other types of buildings. Therefore ***internal sound-proof*** is very important to ensure quiet and private residential environment. Generally noise contributes to total stress and affects a range of health outcomes indirectly. For example, nuisance noise and annoyance could generate negative psychological effects and raise the levels of biochemical indicators of stress, which in turn creates other delayed health issues, and sleep disturbance could impact the sleeping quality and cause certain diseases if it continued for a long time (Heft 1985).

View from windows

Many studies on high-rise housing indicated that view from windows is one of the most attractive elements for residents (see: Kim 1997, Yuen, Yeh et al. 2006, Jim and Chen 2009, Jim and Chen 2010). It has also been shown that passive viewing of nature through windows promotes positive moods and reduces stress (Raw, Aizlewood et al. 2001). On the contrary, being in an environment without view affects mood, the emotions and physiological arousal, which could lead to adverse emotional states, psychosomatic and stress symptoms. A windowless space does reduce the amount of visual, auditory and thermal input received from the outside world and can be considered a milder form of deprivation (Lawrence 2006). For high-rise housing, views have very significant relationships with the value of properties. Two studies in Hong Kong found that the attractive natural views could increase the value of high-rise apartment by over 2.97%, while the street and building views could reduce the value by 3.7% (Jim and Chen 2009, Jim and Chen 2010). Therefore, in the process of planning and design of high-rise housing estates, view from windows is a significant design element to impact the layout of dwelling unit, dwelling building and housing estate.

Private outdoor space

Lack of private outdoor spaces is one of the main differences between high-rise housing and garden house. Human being has the instinct requirement to connect with outdoor natural environment. Despite the large communal green areas within high-rise housing estates, the private outdoor spaces cannot be replaced due to certain private or dairy needs such as gardening, drying clothes and recreation in good weather (Huang 2006). Especially for children and the elderly, private outdoor spaces are more necessary to supply the area of outdoor activities due to their accessibility (see: Devlin 1980, Marmot 1983, Duffy and Willson 1985). For high-rise housing, except the apartments of ground floor could have private gardens, others can only have balconies as the private outdoor space. Balcony is one of the Liveable elements that could be incorporated into the design of high-rise buildings. It not only can provide valuable outdoor open space for residents, but also can be a more sensible solution to traffic noise and air pollution without compromising views and urban images (Chau, Wong et al. 2004). Moreover, balconies can increase the depth of the façade and reduce the solar heat gain to improve the indoor thermal comfort. With effective planting and landscaping, balconies can help catch the wind to enhance natural ventilation (Yau 2002). Last but not least, balconies also provide outdoor space for natural drying of clothing and beddings, which can reduce energy consumption of utility of drying machine and decrease sanitary problems with direct sunlight on drying things (Niu 2004).

Privacy, safety and perceived comfort within high-rise dwelling unit

Privacy, safety and comfort are the fundamental composite indicators of liveable residential environment, and all of which are based on the perception of residents on residential environment. Physical environments can help or hinder our need to find solitude and identify our own personal private 'territory'. Lack of privacy and control over one's living space may damage social relationships, incite aggression, abusive behaviour, and substance abuse (Butterworth 2000). For high-rise housing, the interferences with privacy mainly comes from the visual and auditory impacts of family members or neighbours. Accordingly, the design and construction of windows, doors, walls, floors and ceilings need to fully consider the need of privacy. Safety of high-rise dwelling could be influenced by the height of floor that resident live and window forms, such as French windows and bay windows that may make people feel unsafe. Meanwhile, it is related with the personal experience of the resident. A study by Mackintosh (1982) showed that residents who have lived in high-rise housing are more likely to adapt to high-rise living. Comfort of high-rise dwelling is also a composite indicator that could be associated with many design elements. As mentioned above, thermal environment, indoor air quality, noise and even views could impact residents' assessment on comfort of high-rise residential environment (Dear and Leow 1990). In summary, indoor privacy, safety and comfort consist of the psycho-social dimension of high-rise residential environment at the scale of dwelling unit.

Affordability (Property cost)

Affordability of housing is one of the most fundamental liveability elements (Heylen 2006, Leby and Hashim 2010). Ironically, massive high-rise housing estates have been constructed as affordable housing in order to resolve the housing shortage, but high-rise housing itself means higher construction cost and operating cost than other housing forms (Priemus 1986, Strebel, Jacobs et al. 2005, Zhu and Chiu 2011). Even Kenneth Yeang (1999), the famous designer and promoter of sustainable high-rise building, had to admit that there is an inherent conflict between tall building and low cost. From the perspective of residents, the level of long-term living expenses can directly influence their quality of life. Specially facing the escalating water, gas and electricity prices, the basic expenses for maintaining high-rise living are bound to cause a greater burden. Moreover, the public and semi-public facilities and spaces for high-rise residents need to be managed and maintained by organizations, which leads to another property cost – service charge for property management. Finally, all of these expenditures are borne by each household. Therefore, the residents' opinions on the property cost of high-rise housing have become a significant indicator for its liveability.

2.5.2 Dwelling Building: the liveable collective residential building

Building form and building height

Building forms of high-rise housing can be divided into two types: slab block and tower block. As the historic retrospect of high-rise housing showed (Section 2.3.2), slab high-rise housing derived from the German Zeilenbau: the arrangement of slab blocks, row after row. It has been considered as the most scientific layout, because it can achieve better daylight provision, privacy and less noise for most of flats in same buildings (Glendinning and Muthesius 1994). Walter Gropius in his well-known book of 1935, *The New Architecture and the Bauhaus*, described his ideas that 'the sun should determine the orientation of houses', and the slab blocks should be aligned from north to south, which can provide every flat with adequate sunshine (Gropius 1935). However, studies discovered that large slab blocks can create *wall effect* which adversely impact air circulation (Capeluto, Yezioro et al. 2003, Zhu and Chiu 2011). Tower high-rise housing came from the high-rise commercial towers in Chicago, USA, and it is a more economical building form. More flats can be built by the way of tower form than slab form on land of the same area, but at least some of these flats suffer worse orientation, daylight and ventilation. Although new technologies and creative designs continue to improve the liveability of tower high-rise housing, generally speaking, slab high-rise housing have better liveability than tower ones.

Building height is another element that influences the liveability of high-rise housing. Many studies found that building height can not only influence the psychological feelings and health of residents, but also impact the surrounding micro-climate environment (Capeluto, Yezioro et al. 2003, Zhu and Lin 2004, Zhu and Chiu 2011). Residential building height can directly influence the distance between them, and then influence wind and sunlight permeability (Zhu and Chiu 2011). Meanwhile, the building height would impact the other buildings to share good views and ventilation (Capeluto, Yezioro et al. 2003, Zhu and Lin 2004).

Building elevation, identity and construction quality

Building elevation of high-rise housing has relationships with its liveability from two perspectives: functional and aesthetic. Building facade design could influence the indoor day-lighting and ventilation by the structures, such as sun shields, bay windows and balconies. In some situations, the structures for outdoor units of household air-conditioning and solar panel would affect the elevation design. In addition, as an important part of building envelope, *building elevation design* and *construction quality* could impact on the indoor thermal comfort and energy-efficiency (Bojic, Yik et al. 2001, Bojic, Yik et al. 2002, Cheung, Fuller et al. 2005). Building elevation as an important part of urban view could influence the value of the property and the *identity* of residents (Jim and Chen 2009, Jim and Chen 2010). Especially in high-rise housing estates, the majority of buildings' elevations are similar and monotonic, which result in the loss of identity and the reduction of environmental quality.

Communal spaces and facilities in dwelling building

Having many families in the same building and sharing communal spaces and facilities is one of the characteristics of high-rise living. Those spaces and facilities are the integral part of high-rise residential environment, and directly affect its liveability. From the viewpoint of communal space, its ***lighting***, ***ventilation*** and ***accessibility*** are the main issues on liveable environment design, especially when families with children and the elderly live in the same high-rise housing (Seik 2001, Appold and Yuen 2007, Yuen 2011). Studies indicated that high quality lighting in indoor communal spaces can efficiently improve residents' safety and encourage their interaction; effective ventilation can improve air quality and increase fire safety; good accessibility design can offer a friendly and safe environment to the elderly and children, which can promote the diversity of residents and enhance social cohesion (Helleman and Wassenberg 2004, Yuen 2007, Mak, Cheung et al. 2009).

Among public facilities, the ***quality and quantity of lifts*** is a significant element that directly relate with residents' satisfaction on high-rise residential environment. Lifts are important for access to different floors of apartment buildings especially for those living above the 5th floor, the disabled and impaired. Meanwhile, this is a comfort issue as people will not wish to walk up many/any flights of stairs to get access to their particular floor. High-quality lifts can give the residents living on higher floors more safety with less worrying about the breakdown of lifts, and the quantity of lifts can influence the length of waiting in peak-time (Yeh and Yuen 2011, Yuen 2011). Some researchers also noted a lack of service lifts is a problem particularly when people are moving furniture, which means there could be a conflict in usage and passenger lifts can be damaged if used (Bennett 2010).

As communal spaces and facilities, their ***management and maintenance*** have to depend on both professional agency and residents' participation, and the level of upkeep could moderate the performance of daily use. Many studies found that the anti-social behaviours in these public spaces have significant relationships with management of entrances and maintenance of facilities (Cozens, Hillier et al. 2001, Shaftoe 2007). Meanwhile, the ***collection of domestic waste*** within high-rise residential building could impact the quality and use of communal spaces, and could lead to the spread of odour and even the transmission of diseases such as SARS (Kazaz and Birgonul 2005, Baldwin, Poon et al. 2009, Wong 2010). In addition, waste disposal do contribute to the degradation of the environment and can be a source of infection, which indicate that the control of wastes is relevant to community health (Raw, Aizlewood et al. 2001).

Household density within high-rise dwelling building

One of the main controversies on high-rise housing is the over-crowded environment where many families live in one huge building and the fact that the majority of them are off the ground (Conway and Adams 1977, Haber 1977, Littlewood and Tinker 1981, Mitrany 2002). Studies suggested that population density has directly relationship with the quality of living space (Chan 1999, Chan, Tang et al. 2002). However, the population density in one high-rise residential building cannot be correctly calculated due to the turnover of residents and the diversity of families. Therefore, household density is a more practical element that can measure the level of population density within the same building. Moreover, household density is a main indicator to determinate the standard of infrastructure, communal spaces and facilities, such as water supply system, fire prevention zone, and lift, etc.

Safety and security in high-rise dwelling building

Safety is not only a perception of residents on their residential environment, but also a fundamental issue of high-rise housing design. The consideration of safety is mainly stated from the terms of people and buildings, and there are numerous regulations and laws to ensure the safety standard of high-rise housing (Wong 2011). From the viewpoint of people, safety issues include fire safety, safety to prevent falling, theft safety, etc. Among these issues, fire safety is the most important one for high-rise residential building where many families live in. According to the summary by Raw, Aizlewood, & Hamilton (2001), fire in housing could result in impaired vision due to smoke, respiratory and breathing difficulties, narcosis from inhalation of toxic gases resulting in confusion and loss of consciousness, pathological changes to the brain and pain to exposed skin and the upper respiratory tract followed by burns and/or hyperthermia. Therefore, emergency access and utilities are very important in terms of escape from fire. From the perspective of building, structure safety is the fundamental issue that is defined as conformity to structural requirement (Wong 2011). Among the potential considerations, earthquake is a significant element that influences the design of high-rise housing. Although the structure of high-rise buildings use anti-seismic design and are safer than those of low-rise buildings, the psychological impacts on residents living in and other surrounding people cannot be eliminated. At the present stage, few studies of tall buildings have examined the preferences and perceptions of non-residents, despite more people have to look at high-rise buildings than live in any given building (Gifford 2007). On the other hand, security in high-rise residential buildings is a pivotal element that could influence their liveability. Because numerous families live in one building, residents are not likely to be very familiar with each other, which result in the decrease of monitoring capability of residents. Furthermore, a great number of communal spaces without effective monitoring in buildings provide the potential places for anti-social behaviours. Therefore, the number of entrances is usually designed as few as possible, and communal spaces and facilities are managed and monitored by certain means such as concierges, CCTV and building intercom system.

Relation with neighbours

As the controversy about high-rise housing showed, this housing form does not encourage social interaction especially inside the building due to lack of interaction spaces (Gifford 2007). On the contrary, the overcrowded residential environment usually deteriorates the relationships among residents. Undoubtedly, good social relations are very significant for residents' satisfaction with their residential environment, and many studies have provided the evidences to support this view (see: Ginsberg and Churchman 1985, Hastings 2004, Adriaanse 2007). According to the experiences in Hong Kong and Singapore, more open space, better views and greenery, larger lobby and lift hall can create more opportunities for residents to interact with each other and form a better psycho-social environment (Yuen, Yeh et al. 2006, Lau 2011).

2.5.3 Housing Estate: the liveable gated community

Green areas and landscape

Green areas and landscape are important elements that combine urbanism and nature to create healthy, civilizing and enriching places to live, particularly for high-rise living with its heightened verticality and high density (Yuen 2011). Meanwhile, the home and its neighbourhood have been the main space where the majority of residents relax and socialize, children play, and the elderly spend most of their time (Forrest and Williams 2001). Therefore, the provision of high quality green areas and landscape in high-rise housing estates has become an integral part of liveable residential environment. Studies indicated that public green spaces could affect residents' mental and physical health. For example, Jackson (2003) found that visual and physical access to greenery is the principal key to residents' health. The provision of access to green space encourages more walking and cycling and generates opportunities for informal social contact and interaction, which increases physical activity and mental well-being as sustained exercise is incorporated into daily routines (Evans 2003, Rao, Prasad et al. 2007)

As Yuen (2011) pointed, under current sustainable development narrative, 'greenery in high-rise housing is not an ornamental, marginal provision but a functional, integral component of high-rise living'. Those green areas and landscape not only make monotonous high-rise housing become more aesthetically attractive, but also create various opportunities to reinforce the *sense of community* and ‘place making’. Particularly in large-scale high-rise housing estates, ***play areas for children*** and ***activity places for the elderly*** offer convenient familiar settings for relaxation, discovery and social interaction with peers, neighbours, and family, this can improve the liveability of residential environment. However, the rich literature on green public space in high-rise housing come from Hong Kong and Singapore, where the tropical climate have no significant change of seasons. Therefore, the topics on outdoor environmental situations in different seasons have been barely explored. In those areas with significant seasonal fluctuation, understanding the relationships between the residents and green spaces in different seasons becomes more important.

Internal traffic system

In high-rise housing estate, regardless of whether it is gated community or open community, its traffic system is an important part of residential environment. From the perspective of residents, there are 4 major elements that influence their daily lives in high-rise housing estates: ***pedestrian walkways***, ***motor roads***, ***parking lot*** and ***barrier-free design***. Because of high population density, its traffic system is always bearing greater pressure, especially for motor roads and parking lot. Some studies indicated that congested roads during the peak-time and inadequate parking spaces have become the main negative issues that influence residents’ quality of life (Cramer, Torgersen et al. 2004, Walton, Murray et al. 2008, Yeh and Yuen 2011). Pedestrian walkways and their accessibility designs are also important for children, the disabled and the elderly to go out safely and conveniently, particularly in those large-scale high-rise housing estates where people have to walk farther. There are some special design of traffic system such as separation of pedestrians and cars by an orthogonal system of raised main roads in order to improve the efficiency and safety (Frank 2004, Helleman and Wassenberg 2004).

Internal public service facilities

The experience of successful high-rise housing estates indicates that accessibility and availability of daily life facilities within a comfortable walking distance can significant impact on the liveability of residential environment (Turkington, Kempen et al. 2004, Yuen 2011). In some regulations on design and planning of high-rise housing estate, there are clear articles to list the neccesary public facilities that should be provided, such as nursery school, shops, clinic, community center, etc. In some luxury estates, certain additional facilities such as swimming pool and gym, could be built in order to attract wealthy residents. To some extent, the standards and types of public facilities can decide the value of the property and the satisfication of occupants (Benson and Hansen 1998, Mohit, Ibrahim et al. 2010, Tang and Yiu 2010). Moreover, the standard and types of public service facilities are related with the scale and population of high-rise housing estate. It is noteworthy that the public facilities at the level of community are different from those of the neighbourhood that usually consists of several estates. Those public facilities serve more people, such as primay school, middle school, hospital, bank, post-office, shopping center and recreations.

Population density

High-rise housing estate has become a housing development unit that is designed and planned in a unified way, constructed and delivered step by step. During this period, population density at the level of community is the fundamental element to control the residential environmental quality, which is related with both public spaces and public service facilities (Lai 1993). From the viewpoint of residents, they can perceive population density of different scales from a room, a dwelling unit, a dwelling building, a housing estate, a neighbourhood unit, to the town and city. The distinction of population density between high-rise housing and other housing types is reflected in two main levels: dwelling building and housing estates. There has been rich literature that focused on the negative impacts of overcrowded residential environment on residents' health and satisfaction (see: Saegett 1979, Heft 1985, Bordas-Astudillo, Moch et al. 2003). Some researchers noticed that the context of culture and climate could influence people's tolerance towards crowding, which shows the necessity and complexity of population density research (Yuen, Yeh et al. 2006, Gifford 2007). Above all, population density in high-rise housing estate is an important element that directly influences the liveability of high-rise residential environment.

Building density, spacing and outdoor environment

Building density and distance among buildings can impact day lighting and wind, which can influence the micro-climate, indoor and outdoor environment of high-rise housing estate. High building density always associates with small distance among buildings, poor ventilation and day light, which could reduce the privacy, worsen air quality and deteriorate views and public spaces. These negative effects could result in residents' dissatisfaction and even impact their health due to reduction of outdoor activities and increase of sense of depression (Myhr and Johansson 2008). High building density associate with some internal conflicts. For example, in summer, the outdoor shading of high-rise housing allows people to use outdoor areas without adverse health effects such as sunburn and heat stroke, but in winter, those shading could become the unpopular places because of the cold. Despite of the benefits in summer and troubles in winter, in fact, outdoor shading devices are often too small for summer use due to high sun elevation angle and too large for winter use due to low sun elevation angle. As a result, the outdoor environments of high-rise housing estates in different seasons usually show significant discrepancy (Yang, Lau et al. 2010). On the other hand, building density and spacing between buildings are directly related with development intensification, with higher density meaning more properties, higher profits, and better land efficiency. Therefore, it is very important to find the appropriate building density and spacing that can ensure the liveability of high-rise residential environment, while achieving high land utilization rate.

Wind environment

The wind in and around the built environment can affect liveability in many ways. It not only can affect residents' sleeping and rest through wind noise (Assefa, Glaumann et al. 2007), but also affects ventilation and indoor comfort (Niu 2004). In addition, high-rise building can lead to high-speed wind from high altitude to the ground, which could deteriorate the wind environment and affect pedestrian safety (Jones, Alexander et al. 2004, Wang, Liu et al. 2007). Moreover, high-speed wind could impact the vegetation of landscape plant and the quality of public spaces. Once communal outdoor facilities and open spaces are located in inappropriate positions with poor wind environment, their function and utility could be greatly affected (Roulet 2001).

Wind environment of high-rise housing is also related with outdoor air quality. Studies indicated that the majority of contaminant and pollutants in outdoor air come from traffic, combustion and waste especially in the high-density urban areas, and effective air ventilation can help reduce pollutant concentration and improve air quality, and inferior wind environment could cause high age of air and poor air quality (Morawska, He et al. 2001, Chau, Wang et al. 2011). Therefore, some cities with many high-rise buildings such as Hong Kong and Singapore, have established a set of qualitative guidelines and the frameworks to carry out air ventilation assessment in order to achieve better wind environment (Lau 2011).

Maintenance, management and sense of community

Normally high-rise housing estate is a development unit that is planned, designed, constructed, maintained and managed as a whole. Different with other housing types, maintenance and management of high-rise housing have to depend on more professional technology and equipment, which require professional undertaking by specialized property management companies. Therefore, gated communities have become a popular management form, due to their unified spatial identity as well as the advantages in generating the sense of community (Wilson-Doenges 2000, Blandy 2006, Brunn 2006). Inferior maintenance affects residents' physical health through poor sanitation, air quality, and mental well-being through greater psychological distress, as well as impaired safety through potential hazards such as structural safety, electrical safety and lift failure (Singh 1996, Evans 2003, Wong 2011). Management ties into community security, maintenance and cleanliness. It is up to management to ensure that there are effective and adequate maintenance and cleaning schedules in place to ensure occupant health and well-being (Singh 1996). Particularly high-rise housing estates often run smoother with the presence and skill of building managers. They help to provide security for occupants, a good sense of community and help upkeep apartment building standards (Roeloffzen, Lanting et al. 2004, Ta 2006).To foster or to develop a 'sense of community' or 'community spirit' is very important for housing planning, design and development as well as meet practical infrastructure needs. The sense of community can be enhanced by targeted planning and design approaches, such as to encourage visual coherence, diversity and attractiveness of houses and other buildings; to afford sufficient privacy; to ensure residents have easy access to amenities, parks, recreation facilities and neighbourhood centre; to offer pedestrian-friendly spaces; to provide streetscapes so that houses have views of the surrounding neighbourhood; to encourage open verandas and low fences in order to encourage social interaction; and to restrict motor traffic (Talen 1999, Rogers and Sukolratanametee 2009). These approaches aim to construct an environment that encourages networking and neighbourly behavior and increases interaction between strangers, which can strongly develop community spirit (Butterworth 2000).

2.5.4 Urban Neighbourhood: the liveable surrounding environment

Local public spaces and service facilities

At the level of urban neighbourhood, public spaces and facilities usually include square, park, shopping centre, market, amenities, hospital, school, etc. Their standard and quality could be various in different neighbourhoods, which could impact the residents' assessment to the liveability of residential environment. For example, the reputation and quality of schools directly influence the value of local properties and the satisfaction of residents (Pacione 1984, Dennis Lord and Rent 1987, Schwartz, McCabe et al. 2010). Moreover, accessibility and availability of local public spaces and facilities can affect residents' assessment and identification of their residential environment. Many studies found that accessibility of public spaces and facilities can directly impact residents' quality of life even in high-density high-rise neighbourhoods which are usually considered to have better accessibility (Lau and Chiu 2003, Lau and Chiu 2004, Kaido 2005). High population density in high-rise neighbourhoods can increase the pressure on local service facilities, which could result in residents' dissatisfaction with availability of public facilities (Mohit, Ibrahim et al. 2010). Meanwhile, adequate high-quality public spaces and facilities can help residents generate identification and a sense of belonging to their residential environment. These public spaces and facilities always become the visual landmarks that can assist people in reaching destinations and in way-finding, and these elements provide a sense of ease, comfort and safety. Civic amenities such as libraries and churches serve as havens from urban noise and traffic, create opportunities to interact among residents and also provide a sense of belonging in society (Jackson 2003).

Traffic conditions

Traffic situations of neighbourhood mainly include three aspects: private car traffic system, pedestrian and bicycle trail system, and public transportation system, which are related with residents' daily travel and commute. The major challenge of traffic systems in high-rise neighbourhoods is high population density that could associate with traffic congestion and inadequacy of public transportation during the peak time and excess of traffic recourse during the off-peak time. For residents, driving in heavy traffic commonly causes stress, aggression (road rage) and fatalities (Jackson 2003). Humanistic walkways and attractive bicycle trails can encourage residents to travel on foot or by bike, which not only would be conducive to people's health due to higher levels of physical activity, but also could reduce energy consumption in transportation (Burton 2000). More importantly, these ways to travel can create more opportunities of social interaction among residents and enhance social cohesion in neighbourhood. Above all, a good traffic condition is a very important aspect of liveable high-density neighbourhood.

Ambient noise and cleanliness

Noise pollution and cleanliness are two common environmental quality issues associated with high-density high-rise neighbourhood. Study indicated that high-rise buildings running parallel to the roadways could cause the façade effect and canyon effect which can result in high traffic noise reflectance (Lau 2006). Despite residents' preference to the apartments in higher floors due to noise reduction (Lau 2002), however, the actual situation may not be as people have imagined. Inappropriate building façades (noise reflectance materials), inadequate buffers (plants and constructions) and improper orientations with the noise sources could result in poor noise environment even on higher floors (Lau 2011). Therefore, control of noise resources in neighbourhood is the fundamental approach to reduce external noise pollutions, which also indicates environmental noise is an important element of liveable neighbourhood. On the other hand, environmental cleanliness is another element of liveable neighbourhood. Poor cleanliness can have both direct and indirect health effects. It can encourage pests and infestation as well as provide breeding grounds for bacteria and mould (Ranson 1991). Furthermore, due to poor wind environment of high-rise buildings, outdoor air quality could be deteriorated with poor environmental cleanliness. Cleanliness of neighbourhood usually depends on the maintenance and management of local councils, which is considered as a significant indicator to the liveability of neighbourhood (O'Brien, Purser et al. 2006).

Public security situation and neighbourhood attachment

While neighbourhood security commonly exceeds the scope of community management, and those public spaces and facilities mainly rely on local authority to maintain and manage, however, external security situation can directly impact on the security of communities and residents. Neighbourhood accommodates the most daily life of residents, and its security situation influences everyone therein. The perception of fear in the neighbourhood would lead to a high level of dissatisfaction among resident which in turn has a powerful impact on the lives and social behaviours of residents, while fear and perceived danger represent a personal and emotional threat to health (Braubach 2007). Fear of crime can result in people modifying their lifestyle and living preferences and reducing their willingness to participate in external activities, leading to a spiral of decline in communities and neighbourly links (Raw, Aizlewood et al. 2001). From the perspective of high-rise housing, indefensible built environment (Newman 1975, Newman 1996) and chaotic social environment (Power 1993, Power 1997) make security condition become a significant liveability element. At the level of neighbourhood, there are three specific urban design approaches to improve public security: natural strategies, organized strategies and mechanical strategies. Natural strategies include the design and layout of public spaces and facilities, such as providing adequate public lighting, setting up public recreation facilities to attract people for the detection of inappropriate activities. Organized strategies depend on security guards or police to provide surveillance and access control, and mechanical strategies rely on capital- or hardware-intensive security facilities such as alarms, cameras. Although these approaches could effectively improve the security condition, as Jacobs pointed in her notable book: *The Death and Life of the Great America Cities* (1961), this large-scale high-rise housing model itself associates with those unfavourable elements such as lack of diversity of land use, building scale, building age and density, which are likely to be the fundamental reasons for poor security conditions and weak neighbourhood attachment.

Neighbourhood attachment is an important element to indicate the liveability of residential environment at the scale of neighbourhood from the psycho-social perspective. It was defined as a degree of social integration and interaction among the area residents (Woolever 1992). Good social network, positive social interaction and active social participation can benefit residents' health and mental wellbeing especially for the disabled and the elderly. High familiarity between individuals promotes mutuality and empathy, which not only benefit people emotionally and physically from interpersonal relationships, but also benefit the society from the participation of its members in organisations, activities, and associations (Jackson 2003). Further, some studies showed that good social cohesion can improve the security situation of neighbourhood, and increase residents' satisfaction with their residential environment (Weenig, Schmidt et al. 1990, Brown, Perkins et al. 2003).

2.6 Conclusion

This chapter presented the evolution of high-rise housing, theoretical discussion and practical experience on the liveability of high-rise housing estates. It started by clarifying the two fundamental definitions: liveability and high-rise housing estate. It then reviewed the development history of high-rise housing and revealed the mechanisms that high-rise housing estates continually evolved in order to improve the liveability with the developments and changes of macro-context. Through the review on the theories and studies that were documented in existing literature on liveability, two gaps were identified: 1) the lack of a resident-centred theoretical framework; 2) the scarcity of research in the context of China. Based on the practices and findings of the empirical studies, the 58 latent liveability elements of high-rise housing estates were summarized at the four spatial levels: dwelling unit, dwelling building, housing estate, and urban neighbourhood, which formed the liveability evaluation model.

To sum up, three conclusions can be drawn:

1) The evolution history of high-rise housing estates in developed countries indicated that the improvement of liveability was one of the main driving forces for the development of high-rise housing, and two different development strategies were formed in the different macro-contexts:

-- in the cities of Europe, America and Australia where high-rise housing was one option among the diversified housing types, high-rise housing estates were usually purpose-built in attractive locations for special social groups such as students, fashion white-collar workers or wealthy elderly;

-- in the Asian high-density cities including Hong Kong and Singapore where high-rise housing was the only option for the majority of families, high-rise housing estates were comprehensively planned, designed, constructed, managed and maintained in order to provide the liveable residential environment that would satisfy the various needs of all kinds of families, support high-quality living, and continue to be improved through life cycle.

The two development strategies were based on the residents' perception of the liveable high-rise residential environment in the respective macro-context. The former provided the liveable high-rise housing for the special types of households who accepted or preferred to high-rise living, and met their living demands; the later carefully planned and constructed the liveable high-rise housing for the various households according to their diversified housing needs. Both of the two development patterns were established on the practical experiences and findings of many empirical studies on the liveability of high-rise housing.

2) The essence of liveability research is an exploration of liveability performance of residential environment by means of studying residents' actual experience and evaluation. On the one hand, the macro-context could shape the different residential environment features of high-rise housing estates; on the other hand, the macro-context could moderate the residents' subjective experience and evaluation of their high-rise residential environments. Therefore, liveability research needs a resident-centred theoretical framework that should consist of three parts: ***analysis of macro-context***; ***analysis of residential environment features and residents' actual experience***, and ***analysis of residents' liveability evaluation***, in order to meet the needs of both theoretical research and practical development;

3) Based on the existing practical experiences and empirical studies, 58 elements of high-rise residential environment are considered to be of importance to the liveability of high-rise housing estates. These elements, together with the four spatial levels (dwelling unit, dwelling building, housing estate, and urban neighbourhood), form the

liveability evaluation model of high-rise housing estates (Table 2-3).

Table 2- 3 Liveability Evaluation Model of High-rise Housing Estate

4 Spatial Levels / 2 Dimensions	**Dwelling Unit**	**Dwelling Building**	**Housing Estate**	**Urban Neighbourhood**
Physical Dimension	Size, Layout, Storage, Structure quality, Infrastructure, Natural lighting, Natural ventilation, Heating in winter, Cooling in Summer, Indoor Air Quality, Internal Sound-proof, External Sound-proof, Private Outdoor Space, View from Windows,	Building Form, Building Height, Façade Design, Construction Quality, Quality and Quantity of Lifts, Communal Space, Public Lighting, Ventilation of Public Space, Barrier-free Design, Household Density, Upkeep of Public Facilities, Collection of Domestic Waste.	Green Area and Landscape, Play Areas for Children, Activity Places for the Elderly, Pedestrian Walkways, Internal Motor Roads, Car/Bike Parking, Internal Public Service Facilities, Barrier-free Design, Building Density and Spacing, Outdoor Environment in Summer, Outdoor Environment in Winter, Wind Environment,	Local Public Spaces, Local Service Facilities, Noise, Traffic Situation, Public Transportation, Environmental Tidiness,
Psycho-social Dimension	Privacy, Safety, Comfort, Property Cost.	Fire and Seismic Safety, Security in Building, Identity of Building, Relationship with Neighbours	Population Density, Maintenance and Management, Community Security, Sense of Community.	Public Security Situation, Neighbourhood Attachment.

Chapter three

Research framework and methodology

3.1 Introduction

The main aim of this research is to evaluate the liveability of the current high-rise housing estates in China. Four research questions are raised from the perspectives of theoretical and practical concerns:

1. *What are the macro-contextual features of high-rise housing estates in China, and how do the contextual forces shape the high-rise residential environment and impact the residents' perception of the liveable residential environment?*

2. *What are the residential environmental features of high-rise housing estates in China, and what are the residents' liveability experiences of the high-rise residential environment?*

3. *What are the residents' liveability evaluations of the high-rise residential environment in China, and what are the strengths and weaknesses of liveability of high-rise housing estates from the practical perspective?*

4. *What are the correlation between the residents' liveability evaluation, demographic features and residential environment features, and what are the measurement, indicators and dimensions of liveability of high-rise housing estates from the theoretical perspective?*

In order to answer the four research questions, a resident-centred research framework will be firstly established. And then, an integrated research strategy that combined an embedded multiple-case study, historical analysis, qualitative and quantitative survey will be adopted. At last, the research methods will be explained in detail.

3.2 Research framework: a resident-centred liveability study

In the conclusion of *Chapter 2*, based on the review on the existing empirical studies, the liveability research framework should be centred around residents and consist of three parts: analysis of the macro-context; analysis of residential environment features and residents' liveability experience; and analysis of residents' liveability evaluation. Correspondingly, this study developed a resident-centred liveability research framework (Figure 3-1).

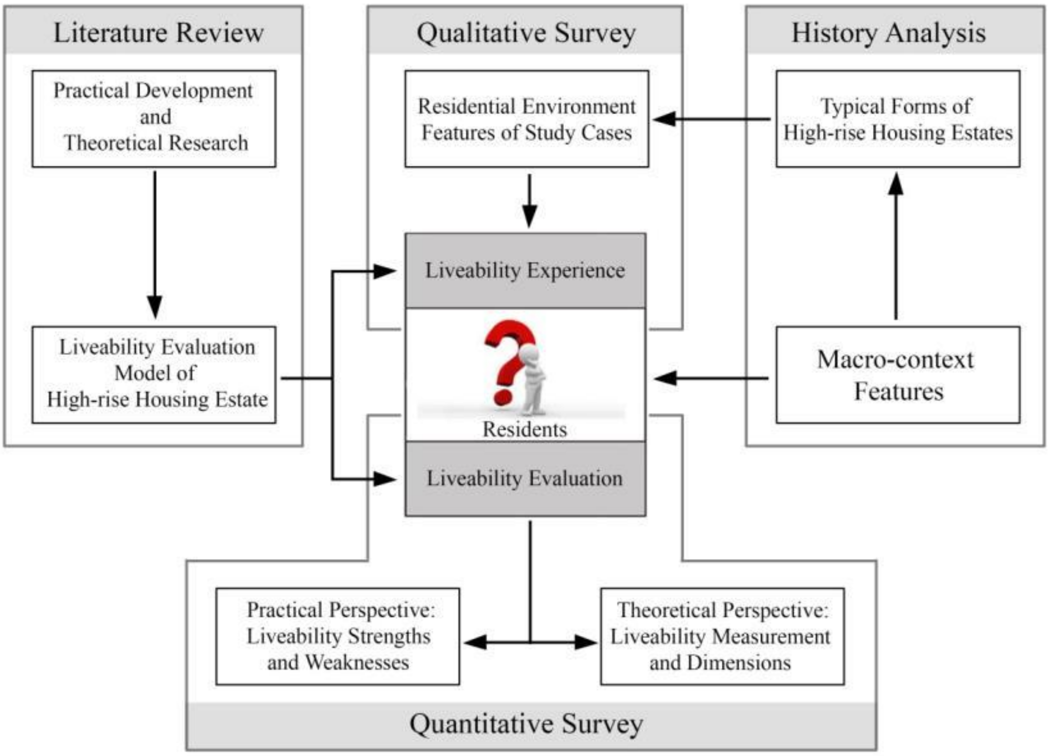


Figure 3- 1 A Resident-centred Liveability Research Framework

This resident-centred framework of liveability study forms the basic structure of this research:

*Chapter 2 (**Literature review**) → **Liveability evaluation model***

*Chapter 4 (**History analysis**) → Research Question 1 (**Macro-context features**) → Research Objective 1: To understand the development and evolution of high-rise housing estates in the context of China, and reveal the mechanisms that the macro-context shape high-rise residential environment and impact residents' resident' living habits and housing preferences;*

*Chapter 5 (**Qualitative survey**) → Research Question 2 (**Residential environment features and residents' experience**) → Research Objective 2: To summarize the residential environment features of high-rise housing estates in China, investigate actual usage conditions and understand residents' liveability experience of the high-rise residential environment;*

*Chapter 6 (**Quantitative survey**) → Research Question 3 (**Residents' liveability evaluation and practical issues**) → Research Objective 3: To analysis the residents' liveability evaluation of the high-rise residential environment, and explore the strengths and weaknesses of the liveability of the existing high-rise housing estates in China to inform the practical development;*

*Chapter 7 (**Discussion**) → Research Question 4 (**Theoretical issues**) → Research Objective 4: To dissect the important theoretical issues on liveability of high-rise housing estates, find out the measurement method, establish the indicator system and summarize the dimensions to develop the liveability theory of high-rise housing.*

3.3 Research strategy: an embedded multiple-case study

Research strategy, or 'research design', is a system of inquiry to conduct the examination on certain theory or hypothesis and to seek for the answers to research questions， which follows a certain research logic to collect and analyse empirical evidence (Zeisel 1980, Yin 1994, Groat and Wang 2002, Zeisel and Eberhard 2006). As analysed in *Section 2.4*, three types of research strategies: *correlational, experimental* and *case study,* were widely used to dissect the impact of high-rise housing on residents, and the lack of a comprehensive research framework focused on liveability of high-rise housing estates is one of the major research gaps.

Based on the resident-centred research framework, ***an embedded multiple-case study*** integrated with ***historical analysis***, ***qualitative*** and ***quantitative survey*** is adopted for the study on the liveability of high-rise housing estates in high-density urban areas of China.

Why '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 have proven the validity of this research strategy, such as Newman's work (1976) on defensible space, and Abel's work (2003) on high-rise building design. According to Groat and Wang (2002), in a narrow research scope, if important elements vary from one case to another, the multiple-case study will be more advantageous than single-case study. Yin (1994) indicated 'every case should serve a specific purpose within the overall scope of inquiry.' This study seeks to discover the relationship between liveability and high-rise residential environment in high-density urban areas from the perspective of housing planning and design. Therefore, the number of cases is decided by the number of types of high-rise housing estates in the spatial-temporal context of China.

According to the history analysis of high-rise housing estates in China (*Chapter four*), in the past decade, high-rise housing estates continued to be built denser and higher to achieve more profit, while trying out different strategies of planning and design in order to find a balance between market acceptation and development intensity. Consequently, four typical forms have emerged with increasing development intensity and population density in the specific macro-context, namely:

- **Slab high-rise housing estate;**
- **Mixed slab and short-slab high-rise housing estate;**
- **Short-slab high-rise housing estate;**
- **Mixed short-slab and tower high-rise housing estate**.

These four typologies of high-rise housing estates form the basis of the multiple-case study.

Why 'embedded'?

Firstly, this study employs the residents' experience and evaluation to measure the liveability of high-rise residential environment. As Amérigo and Aragonés (1990) indicated, the distinct geographical placement of the samples could directly moderate their subjective perception of the residential environments. Moreover, the cultural, social, political and economic factors of the macro-context could subtly influence both residential environment features and residents' living habits and housing preferences. Therefore, the study cases should be selected within the same urban area with minimal contextual difference, in order to minimize the impact of the difference of the external contextual elements and make the research much closer to the ideal situation (Gifford 2002).

Secondly, this study focuses on high-rise housing estates located in high-density urban areas. The main rationality of development of high-rise housing estate is based on the conflict between the increasing housing demand and the limited land (Rudlin and Falk 1999). The decline of high-rise housing estates in the 1970s indicated that the development of high-rise housing estates in low density suburbs was not a sustainable way, while it was difficult to judge whether remote location or high-rise housing per se resulted in the decline (Turkington, Kempen et al. 2004). Therefore, this study focuses on the high-rise housing estates that were developed in the inner city in order to rule out possible influences of remote location on liveability and better understand the liveability of high-rise residential environment per se.

To sum up, an embedded multiple-case study consisting of four cases that respectively represent the four typologies of high-rise housing estates located in the same urban district has been chosen as the research strategy.

Why 'the inner city of Tianjin'?

According to the literature review in *Chapter 2*, the majority of existing studies on the liveability of high-rise housing mainly focused on the developed regions such as Europe, America, Australia, Hong Kong and Singapore. Few studies were found on high-rise housing in China, where the world's largest and fastest urbanization is under progress. In fact, the planning and design of high-rise housing estates in China's cities have been strongly influenced by Hong Kong and Singapore (Yeh and Yuen 2011). Due to the similar culture, climate and economic situations, the studies conducted by Hong Kong and Singapore have high practical significance and reference value for those cities in the South of China, such as Shanghai, Guangzhou, and Shenzhen. However, the cities in the North, including Beijing and Tianjin,, which have significantly different historical traditions and geographical environment from that of Hong Kong and Singapore have not been paid enough attention by researchers. Moreover, the building practice in Beijing and Tianjin has direct impacts on housing development in many northern cities due to the demonstration effect of the central cities. Therefore, from both theoretical and practical perspectives, it is significant and necessary to focus on the high-rise housing estates in large cities in the North of China.

Compared to Beijing, the capital city of China, Tianjin has better representativeness. On the one hand, the historical particularity of Beijing formed a distinctive context that differed from most Chinese cities, especially in terms of the protection of the ancient city including the Forbidden City. On the other hand, the political status of Beijing decided the special pattern of urban development that depended on the huge national investment such as the Olympic Park in 2008. By contrast, Tianjin is a typical industrial city, and is the representation of other northern cities with similar climatic, social and economic situations. The findings in the study of Tianjin would have higher values in both practical and theoretical aspects.

Furthermore, the rationale of choosing Tianjin as research focus is not only based on the author's familiarity and understanding of Tianjin, where the author have been studying, working and living for last sixteen years, but also lies in its abundance of cases for investigation. The large-scale urban regeneration of the inner city of Tianjin started in 2003. The high population density, limited urban land and huge housing shortage boosted the massive developments of high-rise housing estates and provided valuable examples for this research.

3.3.1 Historical analysis: the embedded macro-context of the study cases

Historical analysis is an important research method to understand the evolution and development of research object, to dissect the problems occurred in the past and to reveal the influence of the past on the present (Groat and Wang 2002). On the one hand, as Rudlin and Falk (1999) suggested, the generation and evolution of housing form were mainly prompted by many contextual elements including social, economic and political trends, changes of policies and law, and the influence of reformers. In China, the unique culture, long history, diversified climates and dramatic changes of economy and society in past 30 years not only formed a unique characteristic of high-rise residential environment, but also formed distinctive housing traditions and living customs. On the other hand, liveability research is based on the residents' actual experience and subjective perception of residential environment. Zeisel and Eberhard (2006) believed that 'past use and perception of environments can be the essential contexts for understanding present use and perception'. Therefore, it is necessary to carry out the historical analysis in order to answer the First research question:

> *What are the macro-contextual features of high-rise housing estates in China, and how do the contextual forces shape the high-rise residential environment and impact the residents' perception of the liveable residential environment?*

The historical inquiry of the macro-context follows a chronological approach and consists of three spatial levels: the city of Tianjin, the inner city of Tianjin, and urban settlement in the inner city.

The first part of the historical analysis focuses on the city of Tianjin -- a representative metropolitan in North China. The geography environment, population, climate, and economy development of Tianjin form the fundamental macro-context features. The history of human settlement in Tianjin provides a significant research sample of the development and evolution of China's urban housing.

The second part focuses on the inner city of Tianjin. Similar with many cities in China, Tianjin's inner city is undergoing a rapid urban regeneration process that is dominated by high-rise housing construction in the last decade. The increasing population and limited urban land provided the reality context and ground for a high-rising urban redevelopment.

The third part is focused on the urban settlements consisting of four typologies: Chinese traditional urban neighbourhoods, westernized urban blocks, Soviet-style work units and residential quarters, and Hong-Kong-Style high-rise housing estates. The first three types of urban settlements have been through the long-term development and evolution, impacted each other, and finally influenced the residential environment of high-rise housing estates. Typically, the 4-level hierarchical structure from *urban neighbourhood*, *housing estate*, *dwelling building* to *dwelling unit* is significantly related to both Chinese traditional urban settlement and Soviet-style urban residential area. More importantly, the housing ideology, such as the attention of interior decoration and outdoor landscape, the preference of south orientation and natural cross-ventilation and the collective life style, were continued in the current regulations and codes of urban housing planning and design, and were impacting residents' perception of the liveable residential environment. However, in the past decade, the market-oriented and profit-driven urban regeneration resulted in the rapid increase of development intensity, and the Hong-Kong-style high-rise housing estates quickly evolved four typical forms: *the slab high-rise housing estates, the mixed slab and short-slab high-rise housing estate, the short-slab high-rise housing estate,* and *the mixed short-slab and tower high-rise housing estate,* which not only provide the practical basis of the four study cases, but also construct the research macro-context.

3.3.2 Qualitative survey: residential environment features and residents' liveability experience of the study cases

Broadly speaking, survey is a process of data collection, analysis and measurement, and can be divided into two categories: qualitative survey and quantitative survey (Yin 1994). The former produces descriptions on the study object through non-quantitative methods such as site visit, observation and interview, while the latter produces numerical outcomes on the study case by means of statistics methods such as questionnaire.

In this study, qualitative survey is adopted to find the answer to the Second research question:

> *What are the residential environmental features of high-rise housing estates in China, and what are the residents' liveability experiences of the high-rise residential environment?*

The major residential environment features of the four study cases, which respectively represent the 4 typical forms of high-rise housing estates developed in the past decade, are first summarized at four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit. ***Analysis of documents*** including statistics data of housing market, planning and design documents, and ***site investigations***, are also used to find the major differences between the study cases in the following dimensions:

1. Urban neighbourhood: degree of completion of urban regeneration;
2. Housing estate: level of development intensity, planning and community management;
3. Dwelling building: form combination of high-rise dwelling buildings;
4. Dwelling unit: type distribution of dwelling units.

Then, the residential environment features and residents' experience of the study cases are further analysed and investigated case by case according to the liveability evaluation model (Table 2-3) consisting of 58 liveability elements at four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit. Based on ***the analysis of planning and design documents***, ***site investigations*** and ***interviews***, the actual conditions of the 58 liveability elements in four study cases can be revealed, and the residents' use and perception of these elements can be explored, while these two aspects can confirm each other. More importantly, the findings and conclusions provide the foundation to analyse and understand the residents' liveability evaluation in the following quantitative survey.

3.3.3 Quantitative survey: residents' liveability evaluation of the study cases

Quantitative survey is considered as the useful complement to qualitative survey, the combination of quantitative and qualitative approaches can effectively compensate for their respective shortcomings (Marsland, I. et al. 2007). This study employs ***questionnaire survey*** to examine the findings of qualitative survey and find the answer to the third and fourth research questions:

What are the residents' liveability evaluations of the high-rise residential environment in China, and what are the strengths and weaknesses of liveability of high-rise housing estates?

What are the correlation between the residents' liveability evaluation, demographic features and residential environment features, and what are the measurement, indicators and dimensions of liveability of high-rise housing estates?

In this study, the outcome of liveability evaluation (questionnaire survey) consist two dimensions and three hierarchies:

Two dimensions:

- *holistic liveability evaluation (the four cases as a whole, N=214)*
- *liveability evaluation of each case (Case 1: N=49, Case 2: N=51, Case3: N=57, Case4: N=57)*

Three hierarchies:

- *Satisfaction with the overall residential environment*
- *Satisfactions with the four spatial levels (urban neighbourhood, housing estate, dwelling building and dwelling unit)*
- *Satisfactions with the 58 liveability elements (8 of urban neighbourhood, 16 of housing estate,16 of dwelling building and 18 of dwelling unit)*

The first dimension reveals the synthesized liveability evaluation of high-rise housing estates in the embedded context of high-density urban centre; the second dimension explores in-depth the differences of liveability evaluation of the four typical forms of high-rise housing estates.

The first hierarchy reflects the respondents' overall satisfaction of their high-rise residential environments; the second hierarchy reveals the overall satisfaction of each spatial levels; the third hierarchy detailed exposes the satisfaction of each liveability elements.

By comparing the satisfactions, the liveability strengths and weaknesses of high-rise housing estates can be directly found. Those results can be examined and proved by the findings of the qualitative survey.

More important, the in-depth statistics analysis of the data including the respondents' satisfactions, demographic features and residential environment features can further dissect the theoretical issues of liveability research, by examining the correlations between liveability evaluation and respondents' demographic features and residential environment features, exploring the contribution of the four spatial levels to the overall satisfaction of residential environment, finding the effective measurement of liveability, and sorting out the liveability indicators and dimensions.

3.4 Research methods

3.4.1 Document analysis

Document analysis is used for Literature review, Historical analysis and Qualitative survey.

In the Literature review (Chapter 2), document analysis is carried out to review the existing practical experiences and empirical studies in order to find the research gaps, establish the theoretical framework of liveability research, and construct the liveability evaluation model of high-rise housing estates. Materials used include *academic papers* (journal and conference), *books*, and *unpublished theses* relevant to the research on high-rise housing and liveability. In the historical retrospect of high-rise housing estates (Section 2.3), *visual data* including paintings, photographs, and analysis charts were also presented.

In the Historical analysis (Chapter 4), document analysis is the main method to inquiry the history of Chinese urban settlements. The major materials used were second-hand sources including *journal articles* and *books* relevant to the topics of urban development in Tianjin and the evolution of urban housing in Chinese history, and desk-based data including *statistics yearbooks*, *regulations* and *codes* of housing planning and design. Moreover, illustration analysis is another approach to support the historical review. The visual evidences reflecting the actual situations of residential environment in the past were collected. They consist of *maps* (archaeological maps, and aerial maps from Google-Earth), *photographs*, and *planning and design drawings*. The source includes not only *academic journals* and *books* but also *internet databases* and author's *fieldwork photos*.

In the Qualitative survey (Chapter 5), as the complement to site survey, document analysis is used to explore the residential environment features of the four study cases. Materials used include *planning and design archives*, *regulations* and *codes*, *news* and *statistics yearbooks*, and *web-based community BBS* of the four study cases.

3.4.2 Two-stage field survey

A two-stage liveability survey is carried out in the selected cases to understand in depth the residential environmental features and residents' experience (Chapter 5) and obtain data of residents' liveability evaluation on high-rise residential environment (Chapter 6). The liveability survey consists of two stages, and each stage comprises two parts of work.

In Stage One, investigators carried out ***face-to-face questionnaire survey*** of the randomly selected respondents. In the case of obtaining respondent consent, ***preliminary interviews*** based on the questionnaire were simultaneously conducted. The preliminary interviews focused on the respondents' actual experiences of high-rise living, perceptions of the liveability elements and reasons for making high or low evaluations. This comprehensive survey approach can obtain more information while compensating for the shortcomings of each method. However, this integrated approach requires that each investigator has the experience and ability of field survey, as well as the professional knowledge to understand the purpose and content of the survey and research. Therefore, the author employed 4 fifth-grade undergraduate students, who were studying urban planning in the School of Architecture of Tianjin University, as assistants. The students were recommended by their teachers due to their experiences of field survey. Having benefited from a three-year architectural education and two-year urban planning education, all of them were competent in completing the survey tasks.

In order to increase the diversification of the respondents, two surveys in each study case were carried out respectively on weekend and weekday (Table 3-1). Meanwhile, ***detailed site investigations*** were conducted to analyse the residential environment features and the actual usage conditions of high-rise residential environment at the three spatial levels: urban neighbourhood, housing estate and dwelling building. Combined with the information of the preliminary interviews, photos showing residential environment features and residents' actual usage conditions were taken, which provide direct visual evidences. In Stage One of field survey, 214 valid questionnaires were collected and 55 preliminary interviews were conducted (Table 3-2). Among the 214 respondents, there were 14 who were willing to participate in the in-depth interview.

Table 3- 1 Timetable of the Liveability Survey

Survey Date	Target Cases for Investigation
4th (Sat.) & 6th (Mon) June	Case 4: BaoLong Bay
5th (Sun.) & 7th (Tues.) June	Case 1: ShengDa Garden
18th (Sat.) & 20th (Mon.) June	Case 3: TianLin Garden
19rd (Sun.) & 21st (Tues.) June	Case 2: Style of Spring

In Stage Two, ***in-depth semi-structured interviews*** were conducted in the homes of the 14 respondents. ***In-door investigations*** were simultaneously carried out at the spatial levels of dwelling building and dwelling unit. With consent of the interviewees, some photos were taken to interpret the actual usage situations of the dwelling unit and dwelling building. The structure of the in-depth interview is based on the four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit. The emphasis of the interview is to understand the respondents' actual experience of high-rise living and find out the reasons for making the high or low evaluations of the 58 liveability elements.

Generally speaking, the sample size of the questionnaire survey represents 3.4% of the total housing households with a 90% confidence level which means that in 90 out of 100 repetition of survey, the results will not differ more than ±10%. The detailed information on this survey is shown in Table 3-2.

Table 3- 2 Information of the Liveability Survey

Target Cases for Investigation	Sample Size	Total Number of Households	Sample Rate (%)	Number of Preliminarily Interview	Number 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: TianLin Garden	57	1861	3.1	14	3
Case 4: BaoLong Bay	57	1314	4.3	10	4
Total	214	6226	3.4	55	14

Interviews with the estate managers of the study cases were also conducted in order to understand their opinions on the liveability issues raised in the questionnaires and interviews, and grasp their actual experience during the process of community management and maintenance. In total, 18 interviews with 14 residents and 4 managers were conducted between June and July of 2011.

3.4.3 Questionnaire

The questionnaire (Appendix 1) is based on the liveability framework of high-rise housing estates established in *Section 2.5*, and consists of six sections:

- Section 1: individual residential environment information and evaluation of overall residential environment
- Section 2: satisfaction with dwelling unit and its 18 liveability elements
- Section 3: satisfaction with dwelling building and its 16 liveability elements
- Section 4: satisfaction with housing estate and its 16 liveability elements
- Section 5: satisfaction with urban neighbourhood and its 8 liveability elements
- Section 6: personal demographical information and satisfaction with overall residential environment

The questionnaire includes two types of questions: individual information and satisfaction evaluation. The former constitutes the respondents' demographic features and residential environment features. The demographic features of respondents include 6 indices: ***gender, age, level of education, family income, life stage*** and ***household size***. The individual residential environment features of respondents constitute 2 dimensions and 12 indices (Table 3-3).

Table 3- 3 the Individual Residential Environment Features of Respondents

Dimension	Index
Physical Dimension	dwelling unit's **Size**, **Storey**, **Orientation and ventilation**; dwelling building's **Layout**, **Building form** and **Location in housing estate**.,
Psycho-social Dimension	**Type of tenure**, **Length of residence**, **History of high-rise living** (whether or not formerly lived in high-rise housing), **Former housing type**, **Preferred floors** and **Preferred housing type**.

The latter (satisfaction evaluation) consists of 64 questions that construct a three-level hierarchy structure (Table 3-4): the first level consists of the evaluation and satisfaction of the overall residential environment; the second level is comprised of the satisfactions with the four spatial levels: dwelling unit, dwelling building, housing estate and urban neighbourhood; and the third level is constituted of satisfactions with 58 liveability elements (18 elements of dwelling unit, 16 elements of dwelling building, 16 elements of housing estate and 8 elements of urban neighbourhood). This three-level hierarchy structure is used to understand both comprehensive and detailed liveability evaluation of high-rise housing estates, as well as to analysis the relationships between the overall residential environment, four spatial levels and 58 liveability elements.

Table 3- 4 Hierarchy Structure of Liveability Evaluation of High-rise Housing Estate

		Overall Residential Environment			
Four Spatial Levels		Dwelling Unit	Dwelling Building	Housing Estate	Urban Neighbourhood
58 Liveability Elements	Physical Dimension	Size, Layout, Storage, Structure quality, Infrastructure, Natural lighting, Natural ventilation, Heating in winter, Cooling in Summer, Indoor Air Quality, Internal Sound-proof, External Sound-proof, Private Outdoor Space, View from Windows,	Building Form, Building Height, Façade Design, Construction Quality, Quality and Quantity of Lifts, Communal Space, Public Lighting, Ventilation of Public Space, Barrier-free Design, Household Density, Upkeep of Public Facilities, Collection of Domestic Waste.	Green Area and Landscape, Play Areas for Children, Activity Places for the Elderly, Pedestrian Walkways, Internal Motor Roads, Car/Bike Parking, Internal Public Service Facilities, Barrier-free Design, Building Density and Spacing, Outdoor Environment in Summer, Outdoor Environment in Winter, Wind Environment,	Local Public Spaces, Local Service Facilities, Noise, Traffic Situation, Public Transportation, Environmental Tidiness,
	Psycho-social Dimension	Privacy, Safety, Comfort, Property Cost.	Fire and Seismic Safety, Security in Building, Identity of Building, Relationship with Neighbours	Population Density, Maintenance and Management, Community Security, Sense of Community.	Public Security Situation, Neighbourhood Attachment.

To test the validity of the questions set out in the questionnaire, ***a pilot questionnaire survey*** was carried out before the actual survey was delivered. The pilot survey showed that the respondents understood well what they were asked by each question, and the time taken for each respondent to fill in the questionnaire was within a reasonable scale. Some modifications were made on the presentation of the questionnaire as well as on the wording of some questions according to the feedbacks from the pilot survey. Moreover, before data analysis, the content reliability of the questionnaire was examined by statistics approach-- ***Cronbach' alpha*** (α), which is the most common measure to determine the reliability of the questionnaire. And then, the values of ***Alpha if Item Detected*** were calculated to test whether there were liveability elements that negatively impact on the reliability, which can effectively reflect the internal consistency of the questionnaire.

In order to examine the latent impact of different questioning approaches, the respondents were asked to answer two questions respectively at the beginning and the end of the questionnaire:

How would you evaluate your residential environment as a whole? (Evaluation)

Very Bad	Fairly Bad	Neither, Nor.	Fairly Good	Very Good
1	**2**	**3**	**4**	**5**

To what extent are you satisfied with your overall residential environment? (Satisfaction)

Very Dissatisfied	Fairly Dissatisfied	Neither, Nor.	Fairly Satisfied	Very Satisfied
1	**2**	**3**	**4**	**5**

Using statistics tool (Paired-Samples T-Test using SPSS) to compare the answers of two questioning ways, the influence of questioning way on liveability evaluation can be revealed.

Descriptive statistics and inferential statistics were adopted for the data analysis of the questionnaire survey. The former focuses on the distributions of respondents' demographic features and residential environment features, and the liveability evaluation of high-rise residential environment that includes two indices:

The first index is ***satisfaction level*** that is the mean value of residents' evaluations on a 5-Likert scale, with 1 denoting 'very dissatisfied', 2 denoting 'fairly dissatisfied', 3 denoting 'neither dissatisfied, nor satisfied', 4 denoting 'fairly satisfied' and 5 denoting 'very satisfied', which indicates the comprehensive levels of satisfaction; the second index is ***satisfaction rate*** that is the proportional distribution of the respondents who gave different evaluations of residential environmental elements and liveability elements from 'very satisfied', 'fairly satisfied', 'neither satisfied nor dissatisfied', 'fairly dissatisfied', to 'very dissatisfied', which indicates the structural level of satisfaction.

Inferential statistics are used to explore the important theoretical issues on the liveability of high-rise housing estates. These include:

- ***Correlation Analysis*** between residents' demographic features, residential environmental features, and liveability evaluation to examine the relationships among them;

- ***Analysis of Variance (ANOVA)*** of the satisfaction levels to compare the mean values of liveability evaluation;
- ***Regression Analysis*** of the satisfactions with overall residential environment, four spatial levels, and 58 liveability elements to obtain the quantitative relationships among them;
- ***Principle Component Analysis*** of the 58 liveability elements to extract the liveability dimensions.

3.4.4 Research ethics

The survey on the liveability of high-rise housing estates needed to understand the residents' actual experience, evaluation and opinions on high-rise living. In order to collect the data from a suitable variety of population, ethical consent was obtained from the Research Ethics Committee of Welsh School of Architecture of Cardiff University. The approval was obtained for the questionnaire survey conducted with residents (Ethic Approval EC1208.129, see Appendix 2).

The participants were chosen at random. Participation in this research was entirely voluntary. All participants were over 18 years old and there was no criterion for gender.

The main ethical considerations are as the following:

- The design of the questionnaire is based on the existing literature，and has been checked by my supervisor and several experts during the pilot process. The questionnaire is designed as compact as possible. It takes 6 to 10 minutes to answer all questions, which is considered appropriate for a face-to-face questionnaire.
- The site survey was conducted with consent of the resident committees, property management companies and local authorities.
- This study employed face-to-face questionnaire and interview at random. Therefore，the surveyor will introduce the information on this research to every participant，and make them understand the situation on ethical issues. The cover letter of questionnaire also includes the detailed

explanation. The survey was carried out after obtaining the participant's consent. During the process of survey, the participants can omit questions they do not want to answer and can withdraw from participation at any time.

- Interviews were conducted following questionnaire survey, and were anonymized. There were no questions that may result in distress, discomfort and detriment of participants. Participants could withdraw from the interview at any time.
- All the data collected was anonymized and were treated confidentially.

3.5 Conclusion

This chapter systematically explained the methodology adopted by this study. Firstly, it proposed the research questions and objectives. The three research questions proposed constituted the framework of the liveability research: ***analysis of macro-context***, ***analysis of residential environment features and residents' actual experience***, and ***analysis of residents' liveability evaluation***. Based on the research questions, the research strategy was established: ***an embedded multiple-case study*** integrated with ***historical analysis***, ***qualitative*** and ***quantitative survey***. Finally, the specific research methods of data collection and analysis were discussed in detail. ***Document analysis*** was adopted to reveal the impact of the macro-context on residential environment of high-rise housing estates and residents' living habits and housing preferences. ***A two-stage field survey*** was carried out to investigate the residential environment features of the study cases and understand the residents' actual experience and liveability evaluation. ***Questionnaire*** was also used that included three parts: respondents' demographical information, individual residential environment features and evaluation with their residential environment and 58 liveability elements, and using both descriptive and inferential statistics methods for data analysis.

Chapter four

History analysis: the macro-context of high-rise housing development -- the inner city of Tianjin, China

4.1 Introduction

This chapter is focused on answering the first research question:

> *'What are the macro-contextual features of high-rise housing estates in China, and how do the contextual forces shape the high-rise residential environment and impact the residents' perception of the liveable residential environment?'*

The main body of this chapter consists of three sections that respectively focus on the three spatial levels: the City of Tianjin, the inner city of Tianjin, and urban settlements in the inner city. The first section analyses the urban development pattern of Tianjin, as a representative of large cities in North China; the second section reveals the urban regeneration of the inner city that was dominated by high-rise housing developments; the third section dissects in-depth the typology and evolution of urban settlements and residents' living habits and housing preferences that directly impact residents' perception of the liveable residential environment.

4.2 The City of Tianjin: a representative large city in North China

Tianjin is one of the four municipalities that have provincial-level status, reporting directly to the central government. Tianjin's urban land area is the fifth largest in China, ranked only after Beijing, Shanghai, Guangzhou and Shenzhen. 137 km southeast of Beijing and 50 km from Bohai Gulf in the Pacific Ocean, Tianjin is recognized as a major commercial and industrial centre as well as the largest port in North China (Figure 4-1, Left). The municipality of Tianjin has a population of 13.5458 million (2011) and administers a total area of 11,919.7 square km, which includes the inner city consisting of six urban districts; 4 peripheral districts – Dongli, Xiqing, Jinnan and Beichen; the Binhai New Area (BNA); and five suburban districts/counties – Wuqing, Baodi, Jinghai, Ninghe and Ji (Figure 4-1, Right).

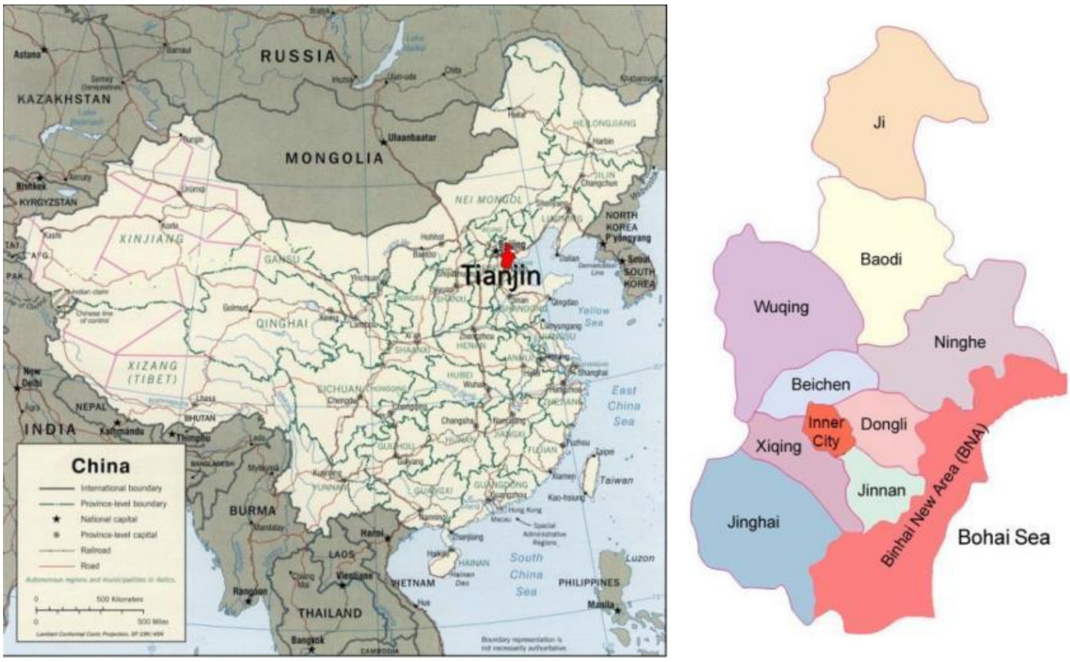


Figure 4- 1 Geographical Location and Administrative Attribution of Tianjin

Source: compiled from the maps on http://www.vmapas.com/Asia/China/China-Political-Map-2001.jpg

Figure 4- 2 Building Climate Region of Tianjin – Cold Region

Source: compiled from the Standard of Climatic Regionalization for Architecture (CABR 1993)

Tianjin is located in the Cold Region according to the Standard of Climatic Regionalization for Architecture (CABR 1993, Figure 4-2). Tianjin features a four-season, monsoon-influenced climate, which is typical of East Asia, with cold, windy, very dry winters, reflecting the influence of the vast Siberian anticyclone, and hot, humid summers, due to the monsoon. Spring in the city is dry and windy, occasionally seeing sandstorms blowing in from the Gobi Desert, capable of lasting for several days. With the low annual total precipitation of 540 millimetres (21.3 in), and half of it occurring in July and August alone, the city lies within the humid continental zone, with parts of the municipality being semi-arid. The climate deeply impacted the people's lifestyles, habits and preference of the residential environment. This influence will be further elucidated later in discussing the Chinese traditional urban residential environment.

Similar with many big cities of China, Tianjin has a long history of human settlement. The opening of the Beijing-Hangzhou Grand Canal during the Sui Dynasty (581–618 AD) prompted the development of Tianjin from an ordinary town into a trading centre. The rise of nearby Beijing as the capital of northern nomadic dynasties and later of the country brought prominence to Tianjin when it served primarily as a storage, sale, and distribution centre for agricultural products from the south to the capital. In 1404 AD, the name 'Tianjin' was first used, meaning 'the Heavenly Ford'. Later, a fort was established in Tianjin, known as "Tianjin Wei"-'the Fort of Tianjin', which was the starting point of Tianjin's urban development (Figure 4-3).

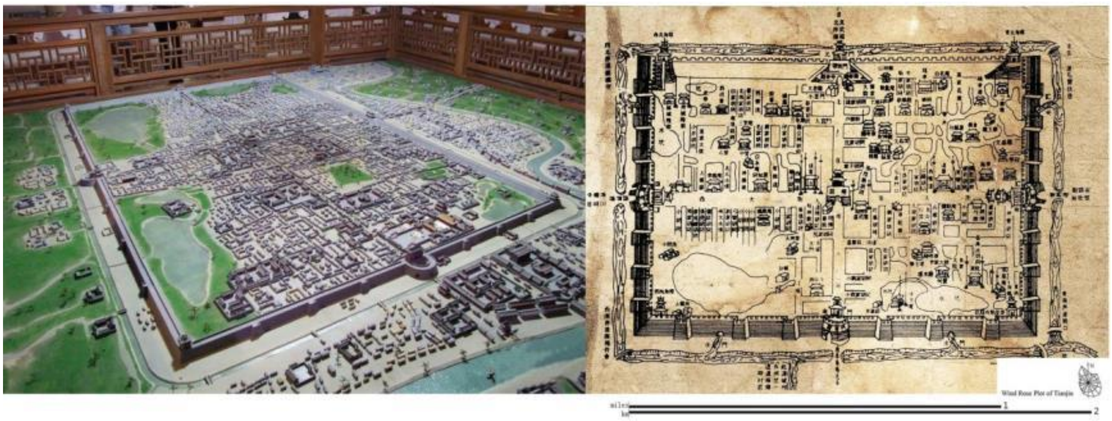


Figure 4- 3 Model and Map of the Old Town of Tianjin in Qing Dynasty (1644-1911AD)

Source: compiled from the photo on http://img1n.soufun.com/bbs/2009_04/07/tj/1239088317534_000.jpg and the map on http://upload.wikimedia.org/wikipedia/commons/f/fb/Old_map_of_Tianjin_City.jpg

In 1860, as a result of the Second Opium War , the Emperor of China (Qing Dynasty) ratified the Treaties of Tianjin, and Tianjin was formally opened to Great Britain and France, and thus to the outside world. Between 1895 and 1900, Britain and France were joined by Japan, Germany and Russia, Austria-Hungary, Italy and Belgium, in establishing self-contained concessions in Tianjin, each with its own prisons, schools, barracks and hospitals. The development and construction of these concessions gradually changed the urban structure and landscape of Tianjin, and the city begun to extend south-eastward along River Haihe, which formed the fundament of the inner city of Tianjin (Figure 4-4). In 1927, Tianjin was given the status of municipality, and became the most important treaty port in North China.

Figure 4- 4 the Old Town of Tianjin and the Concessions of the Western Countries in 1910

Source: compiled from the maps on http://static.ishare.down.sina.com.cn/12243762.jpg

Since 1949, Tianjin has experienced relatively stable development until 1978 when China started the 'Reform and Opening up'. With the rise of international trade, Tianjin once again became an important port city and industrial city in North China. Beginning in 2003, the central government and the local government of Tianjin carried out an ambitious development plan and invested huge funds in large-scale urban regeneration and construction (CAUPD 2005), which accelerated the urban development and dramatically changed the urban landscape. The redevelopment of Tianjin Old Town is a typical example (Figure 4-5).

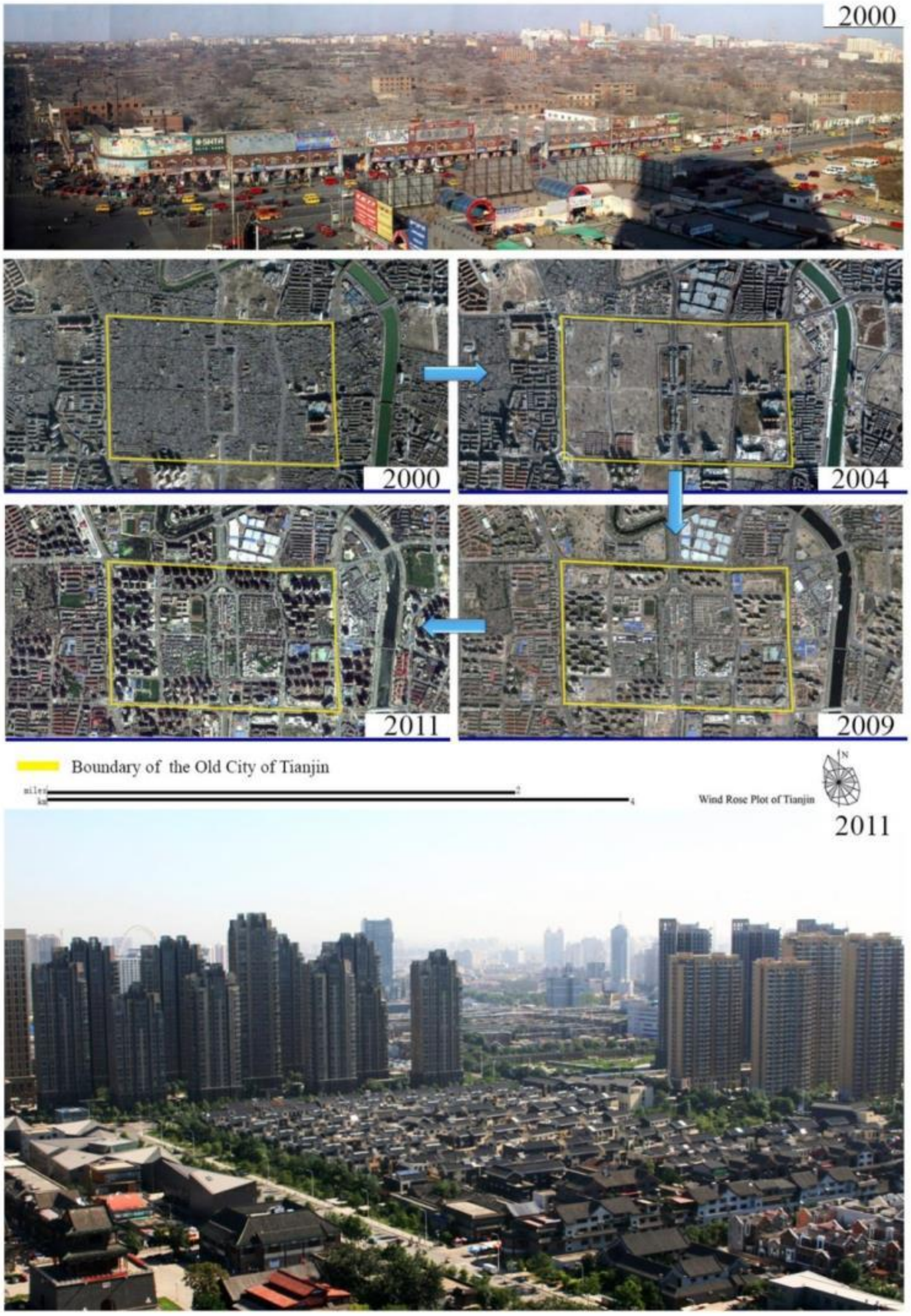


Figure 4- 5 the Redevelopment of the Old Town of Tianjin from 2003 to 2011

Source: compiled from the maps on Googleearth and photos on http://www.picturechina.com.cn/bbs/watermark.php

As a result, the original buildings in the Old Town have been almost completely removed except for several important buildings. In only eight years from 2003 to 2011, a brand new urban neighbourhood with mixed modern high-rise housing estates and archaistic low-rise housing estates have taken shape. In 2011, 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, levels on par with some developed countries (SONBS 2012).

4.3 The inner city of Tianjin: a rapidly high-rising city centre under regeneration

The inner city of Tianjin is comprised of six urban districts: HePing, NanKai, HeXi, HeDong, HeBei and HongQiao, and each urban district contains a certain number of sub-districts that are the lowest administrative agency and the smallest political division of Chinese cities (Figure 4-6). The inner city of Tianjin has a land area of 177.1 square km and a population of 4,501,500 (2011), which means that 1.5 per cent of the land of Tianjin accommodates 33.2 per cent of the total population, and the population density reached 25,422 people per square km in the end of 2011 (SONBS 2012).

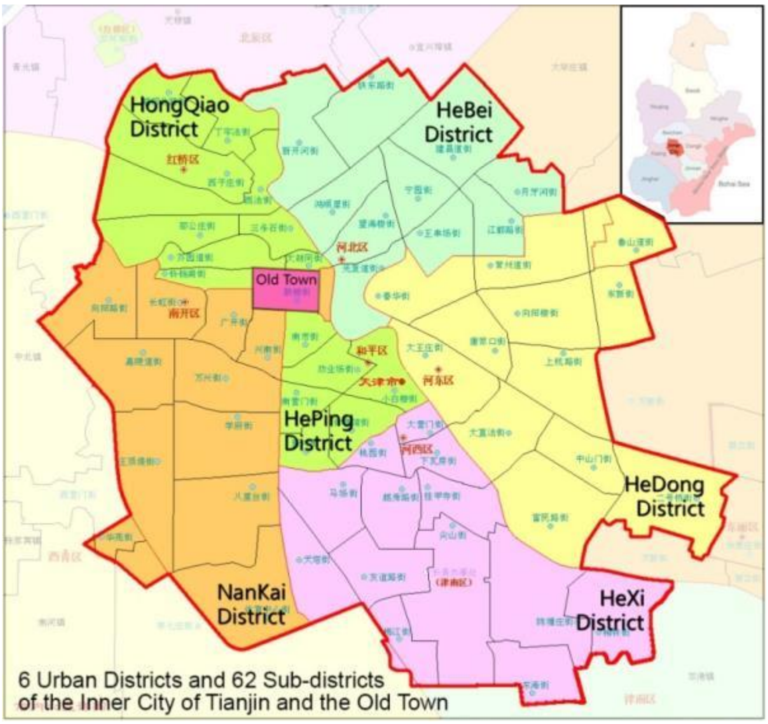


Figure 4- 6 Administrative Attribution of the Inner City and Location of the Old Town of Tianjin

Source: compiled from the maps on http://www.6jc.cn/tools/xz/quhua/12tj/12000c_06zfj.gif

In the past decade, the population in the inner city of Tianjin has increased from 3.74 million in 2001 to 4.50 million in 2011, while per capita residential floor area has doubled from 15.9 square meters in 2001 to 32.8 square meters in 2011 (Table 4-1), which not only reflects the rapid urbanization, but also reveals the rapid process of the huge housing development to meet the increasing demands. However, the urban land is limited, especially for the inner city with the long urban development history. To prevent urban sprawl, the practical strategy is to redevelop the old inner city to build high-density housing, which forms the fundamental driving force to develop high-rise housing estates in the inner city of Tianjin.

Table 4- 1 the Increasing Population and Per Capita Residential Floor Area in Inner City of Tianjin

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Population in inner-city (Million)	3.74*	3.76*	3.81*	3.84*	3.85*	3.84*	4.09	4.28	4.43	4.35	4.50
Per Capita Residential Floor Area (M^2)	15.9	16.7	17.5	18.6	25.0	26.1	27.1	28.5	29.9	31.3	32.8
* Before 2007, the population of inner city only counted those people who have Tianjin ***HuKou.***											

Source: Tianjin Statistical Yearbook (SONBS 2012)

In order to meet the housing demands, improve urban environment and promote economic development, in 2003, large-scale urban renewal was carried out in the inner-city of Tianjin, which accelerated the increase of land prices. Meanwhile, because of the scarcity of land in high-density inner city, development intensity of housing estates and property price continued to rise. Under this background, large numbers of high-rise housing estates were developed with ever-increasing development intensity. According to the data of Tianjin Land Resources and Real Estate Information Network and Property Buyer Guide of Mainstream Tianjin (YJDC 2011), the proportion of high-rise housing estates in new housing developments in inner city of Tianjin have increased from 17% (3 out of 18) in 2003 to 83% (73 out of 88) in 2011 (Table 4-2).

Table 4- 2 the Number and Proportion of High-rise Housing Estates and Other Types of Housing Estates in the Annual New Developments in Inner City of Tianjin

	2003		2004		2005		2006		2007		2008		2009		2010		2011	
	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P
HHEs	3	17%	17	35%	28	49%	43	56%	39	64%	70	73%	79	81%	68	82%	73	83%
Others	15	83%	31	65%	29	51%	34	44%	22	36%	26	27%	18	19%	15	18%	15	17%
Total	18		48		57		77		61		96		97		83		88	
HHEs: high-rise housing estates																		

Source: compiled from the data in Tianjin Land Resources and Real Estate Information Network and in Property Buyer Guide of Mainstream Tianjin (YJDC 2011)

In fact, even in those other types of housing estates, the majority of them included certain number of high-rise dwelling buildings in order to increase the development intensity and achieve more profit. More importantly, because the urban renewal of the inner city adopted a strategy to completely demolish old buildings to develop new high-rise housing estates, not only have the original urban context been changed, but also the diversified housing market including various housing types have gradually been replaced by the homogenized housing market dominated by high-rise housing. High-rise housing estates have become the dominant housing type in the inner city of Tianjin.

4.4 Typology and evolution of urban residential environment in the inner city of Tianjin

During the 600 years history of Tianjin, the various residential typologies have been formed, such as *the Chinese traditional courtyard houses* that were the dominant housing type before 1949, *the westernized townhouses* that were built in the Concessions of the Western Countries from 1840 to 1949, *the Soviet-style residential quarters* that were constructed in the Socialist Planned Economy period between 1949 and 1992, and the recent *Hong-Kong-style housing estates* that were the products of Socialist Market Economy from 1992 to the present. All these different types of housing constituted a diversified urban residential environment with a distinct urban structure (Figure 4-7). The majority of high-rise housing estates began to be developed since 2003, and thus high-rise housing is a very new housing type for the majority of both residents and professionals. Although high-rise housing estates dominated the new housing market, there still exists a huge number of other types of housing.

According to the author’s questionnaire survey, only 22.4 per cent among 214 respondents had lived in high-rise housing before they moved to the present high-rise dwellings. Therefore, it is necessary to analyse the typologies and evolution of urban residential environment, which not only can reveal the influence of the existing housing types on the planning and design of high-rise housing estates, but also contributes to the understanding of the impact of the previous living environment and housing ideology on residents’ experience and evaluation of the present high-rise housing.

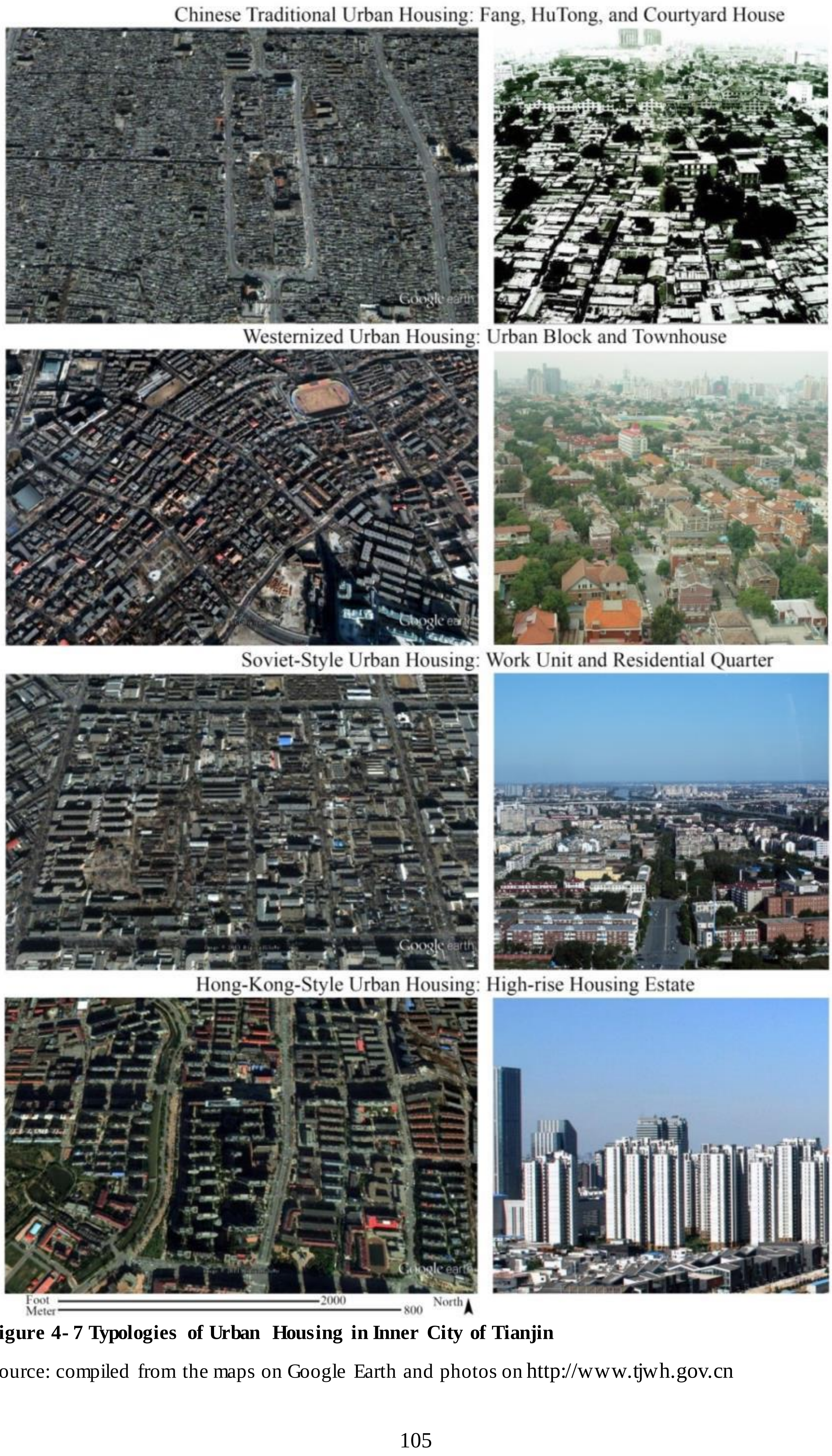


Figure 4- 7 Typologies of Urban Housing in Inner City of Tianjin

Source: compiled from the maps on Google Earth and photos on http://www.tjwh.gov.cn

4.4.1 The Chinese traditional urban settlement: Fang, Xiang and Courtyard House

In ancient China, two groups of ideologies dominated the normative principles of traditional residential planning and design. One is the doctrine of Confucianism, which formulated the appropriate hierarchy of social behaviour and spatial arrangement necessary to achieve an ideal social order. The strict hierarchical ideology formed the five main morphological features of the traditional residential environment, namely *walled enclosure, axiality, north-south orientation, symmetrical layout,* and *closed courtyard* (Liu 1984, Dong 2004). Another one is the notion of Daoist that focus on how to understand and deal with the relationship between individual, society and nature. The pursue of harmony between human and nature (*Tian Ren He Yi*) was the key idea, which promoted the planning and design theory on site selection, orientation, layout, landscape, and garden – *Feng Shui* (Wang 2005). The above two Chinese ancient ideologies together shaped the traditional three-spatial -level urban residential environment: ***Fang*** (Residential ward), ***Xiang*** (internal street, also called *Hutong* in North China), and ***Courtyard House***.

Fang is a residential ward (residential quarter) which is the lowest urban administrative unit in both city planning system and residence management system in ancient China since the Zhou Dynasty (1046–256 BC). According to the Confucian classic writings called *Zhou Li* (written in *Spring and Autumn Period*, 722-483 BC), apart from the King's family who lived in palace, all of the other urban population must live in the walled, strictly controlled *Fang*. The most typical and influential example of the theoretical model is Tang Chang'an (618-906 AD) which housed over one million people with 108 *Fangs* (Figure 4-8).

The whole city was divided into one huge palace, two designated markets and 108 walled residential wards (*Fang*) by eleven north-south and fourteen east-west major streets. These *Fangs* were enclosed by the rectangular earthen walls and moats, and the area ranged from 28 to 93 hectares (Liu, Zhou et al. 2007). Within each *Fang*, there were internal narrow roads called *Xiang* (called *Hutong* in North China) to organize the courtyard houses (Dong 2004). The residents were forbidden to create private gates in the ward walls to the external urban streets, and were not allowed to leave the ward during curfew hours (from about 9pm to 3am), unless a permit was issued in case of an emergency (Heng 1999).

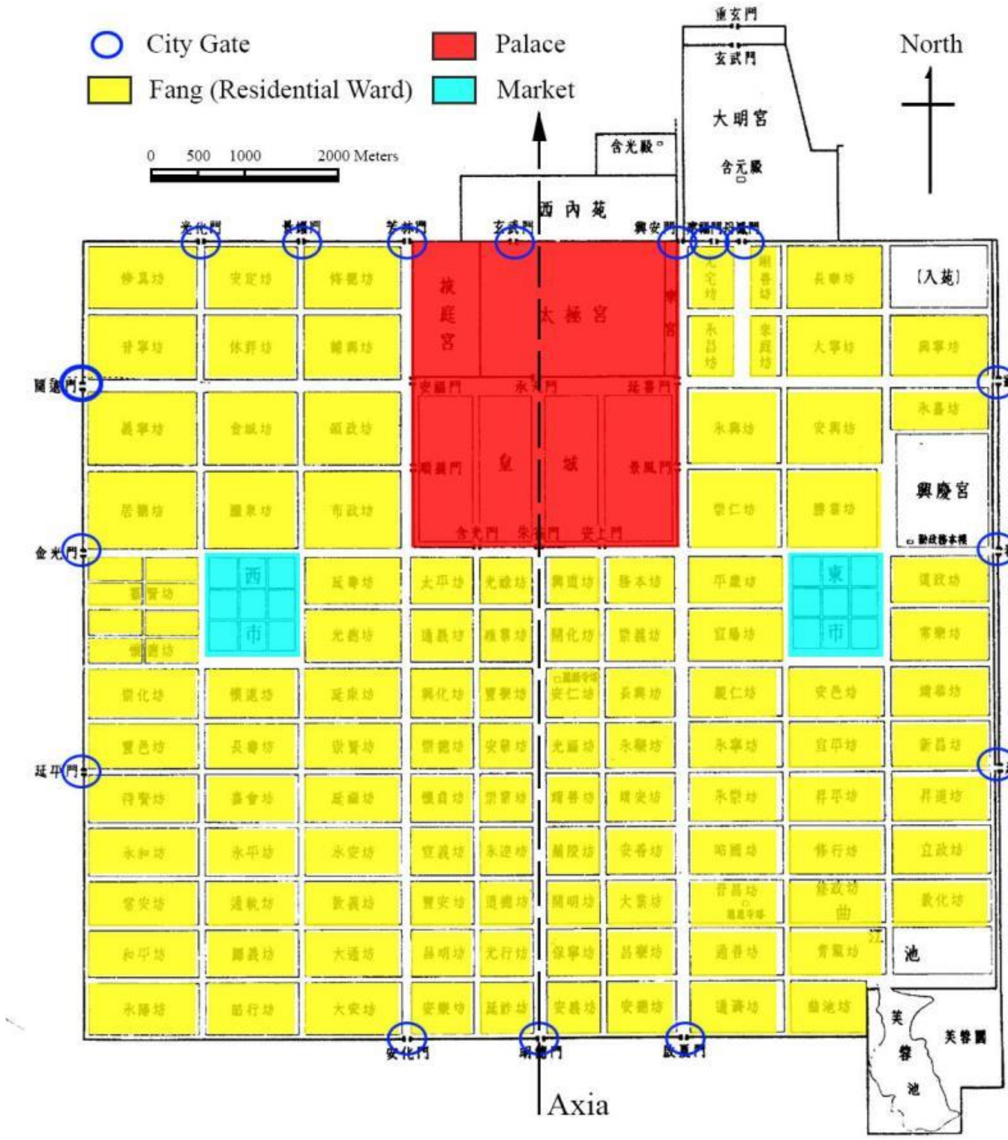


Figure 4- 8 Map of Tang Chang'an

Source: compiled from the map in History of Chinese Urban Construction (Dong 2004)

With the economic growth and long-term social stability, the control of residents and segregation of the residential and commercial function were gradually broken. The walls of *Fang*s were inevitably demolished and replaced by gates and commercial buildings. Eventually, *Fang* became the administrative district with free movement and mixed land-use meanwhile, *Xiang* became an important linear semi-public space shared by residents (Figure 4-9). *Xiang* was defined by the walls of *courtyard houses* on its two sides, and most of them have one or two gates with a nameplate at the gateway, which further enforced the sense of community and territorial control. The basic service facilities including shops and open-air markets gathered around the gateway, serving the daily needs of local residents within a handy distance (Dong

2004). The residential pattern of *Fang*, *Xiang* and *courtyard house* continued to shape Chinese cities until today, and the Old Town of Tianjin was the outcome of this model (see, Figure 4-5).

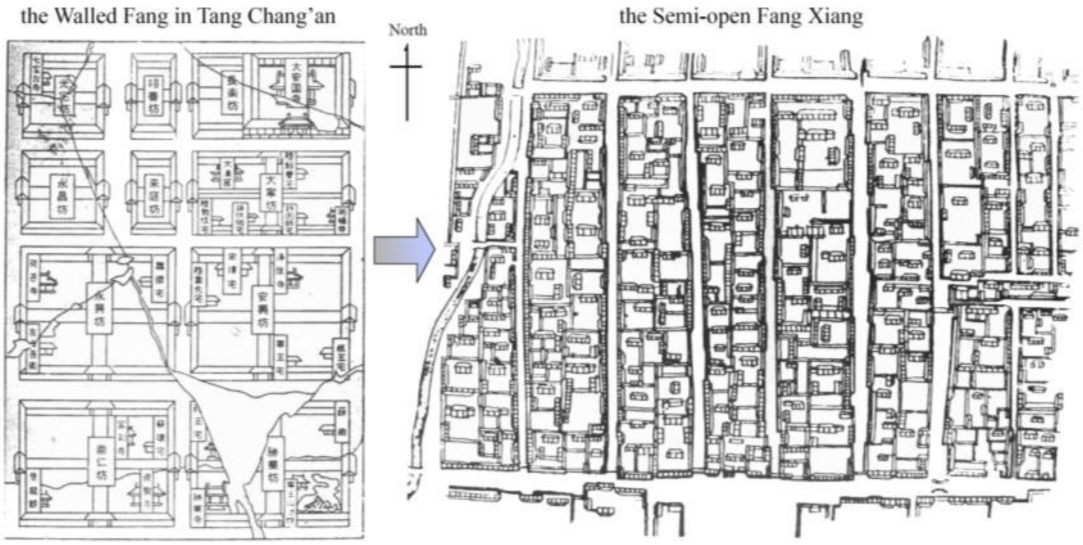


Figure 4- 9 the Transformation from the Walled Fang to the Semi-open Fang Xiang

Source: compiled from the map in History of Chinese Urban Construction (Dong 2004)

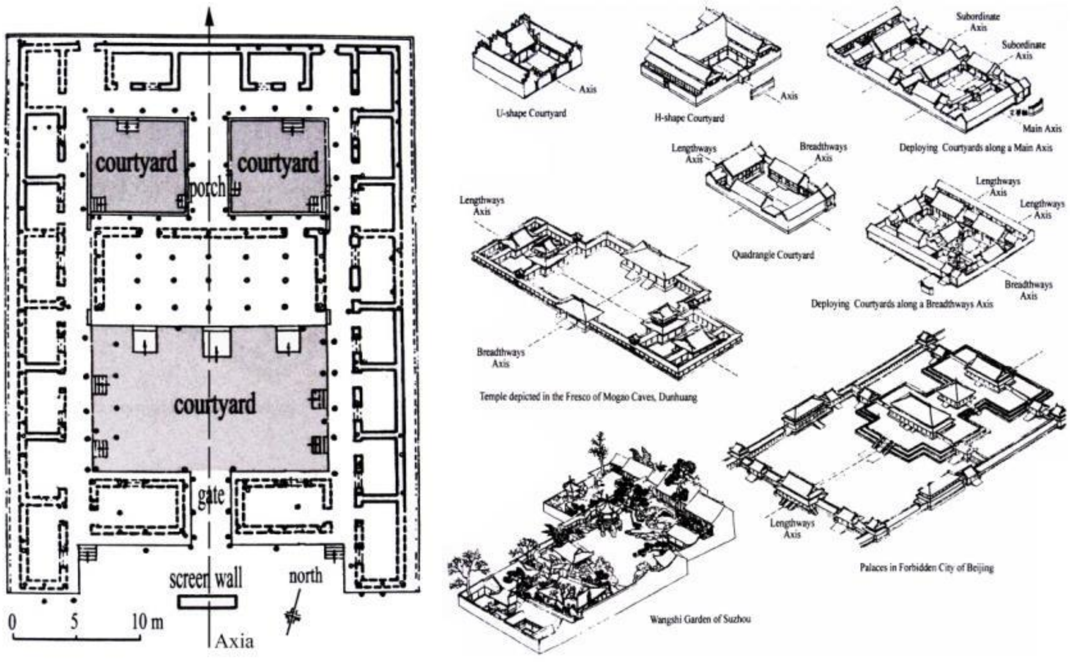


Figure 4- 10 the Earliest Courtyard House and Wide Utilization of the Five Design Principles: Walled Enclosure, Axiality, North-South Orientation, Symmetrical Layout, and Closed Courtyard in Ancient China

Source: compiled from the picture in History of Chinese Urban Construction (Dong 2004)

In Chinese traditional housing pattern, courtyard house is the century-old fundamental residential unit. The earliest archaeological evidence of courtyard was found in the Zhou Dynasty (1046 – 256 BC) (Figure 4-10: Left). The prototype of introverted spatial organisation surrounding the enclosed courtyard was significantly different from the open layout of typical western house standing in a yard or garden, which reflected the distinction in the building-space relationship of housing layout between Chinese and Western traditions (Dai 2008). Moreover, since then, the five design principles of city and building: *walled enclosure, axiality, north-south orientation, symmetrical layout*, and *closed courtyard*, have been widely used to guide the practice (Figure 4-10: Right).

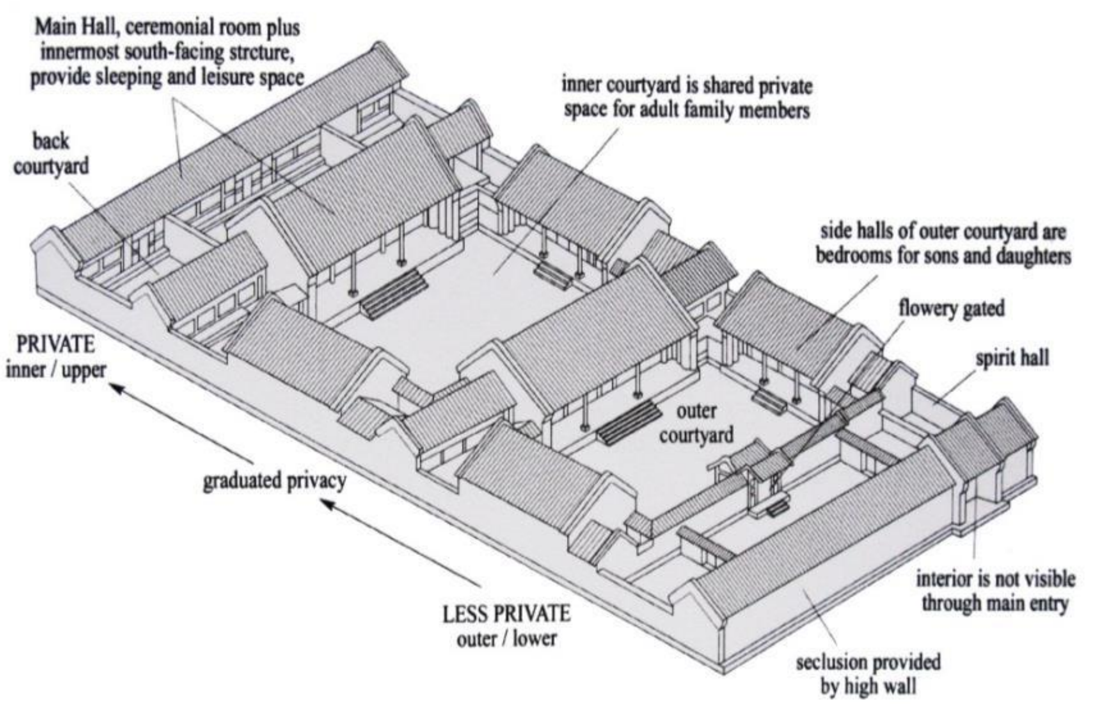


Figure 4- 11 the Layout of a Typical Courtyard House

The location of rooms and spaces in terms of inner/outer, upper/lower, left/right, front/back, and the distance from the central/innermost courtyard defined the kinship status of the household members. And the spatial sequence of entries from the main entry, small reception courtyard, forecourt, flowery gate, outer courtyard, finally to the inner courtyard, achieved the transition from the public to the private spaces. Source: compiled from the picture in Chinese Houses: the Architectural Heritage of a Nation (Knapp 2005)

The layout of courtyard house reflected the collective living tradition of a Chinese family which generally included three or four generations from the same ancestor through the patrilineal line. The proverb 'four generations under one roof' becomes a description of a happy life in Chinese conventional value (Dai 2008). Corresponding to the collective life-style, the Confucian ritual formed the detailed provisions to achieve not only the coordination between spatial organisation of a house and the kinship hierarchical relationship of family members, but also the spatial transition from private individual spaces, the communal spaces shared by the whole family, reception spaces for guests, and the outer public space (Figure 4-11).

Furthermore, the prototype of courtyard house can be easily replicated to meet the demands of the family extension. With four or more generations living together, the combination of multiple courtyard houses can form residential compound for one family (Figure 4-12). In fact, the large residential quarter for one family still keeps the three-level spatial structure from *Fang*, *Xiang (HuTong)*, to *Courtyard House*.

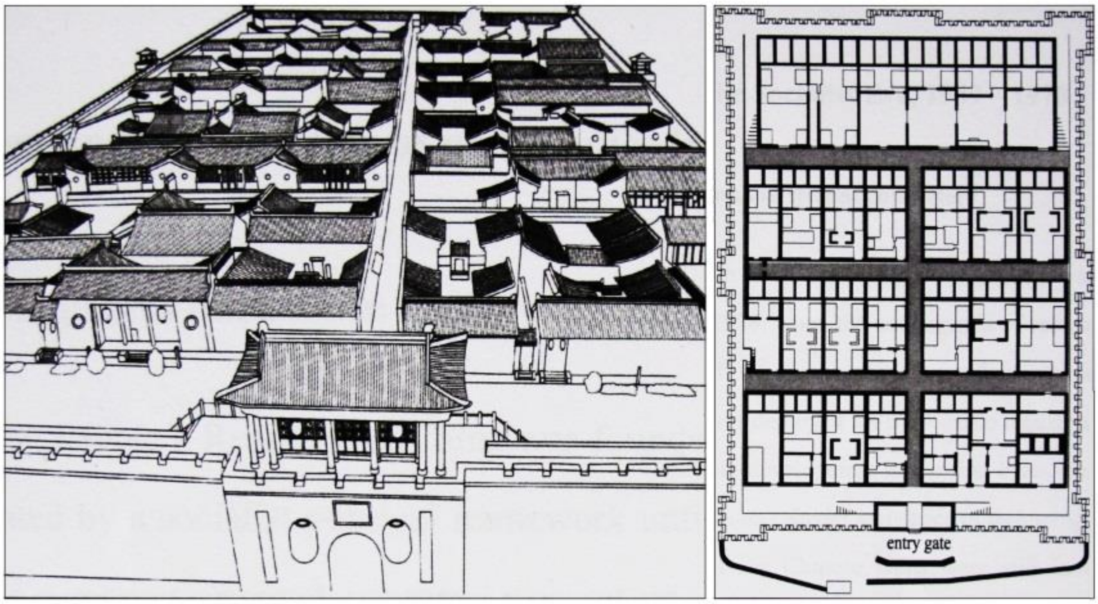


Figure 4- 12 the Combination of Multiple Courtyard Houses: Wang Courtyard for One Family, ShanXi Province
Source: compiled from the picture in Chinese Houses: the Architectural Heritage of a Nation (Knapp 2005)

The decline of Chinese traditional housing in Tianjin

It is undeniable that the transformation of residential environment is based on the economic evolution and development (Dong 2004). The long-term stability of the traditional agriculture economy in ancient China was one of the main reasons that Chinese traditional housing had not changed a lot since it appeared 3,000 years ago (Dai 2008). However, with the beginning of the modernization in urban China, the traditional residential wards and courtyard houses began to decline. On the one hand, the collective life pattern based on the agricultural economy was gradually replaced by the independent living of small families. The courtyard houses were divided into certain dwelling units to accommodate smaller households, which accelerated the deterioration of residential environment because of the increase of population density and the lack of infrastructure and maintenance. On the other hand, the new housing types such as westernized townhouse, Soviet-style dwelling building and Hong-Kong-style housing estates were respectively constructed in different historical periods, and attracted more and more households, which resulted in the reverse elimination and poverty aggregation in the traditional housing compounds. Of course, the social-economic development in urban China not only destroyed a great number of the traditional buildings and houses, but also totally changed the people's lifestyle (Zhang and Wang 2001). Consequently, the courtyard house became the tenement yard, and even urban slum (Figure 4-13).

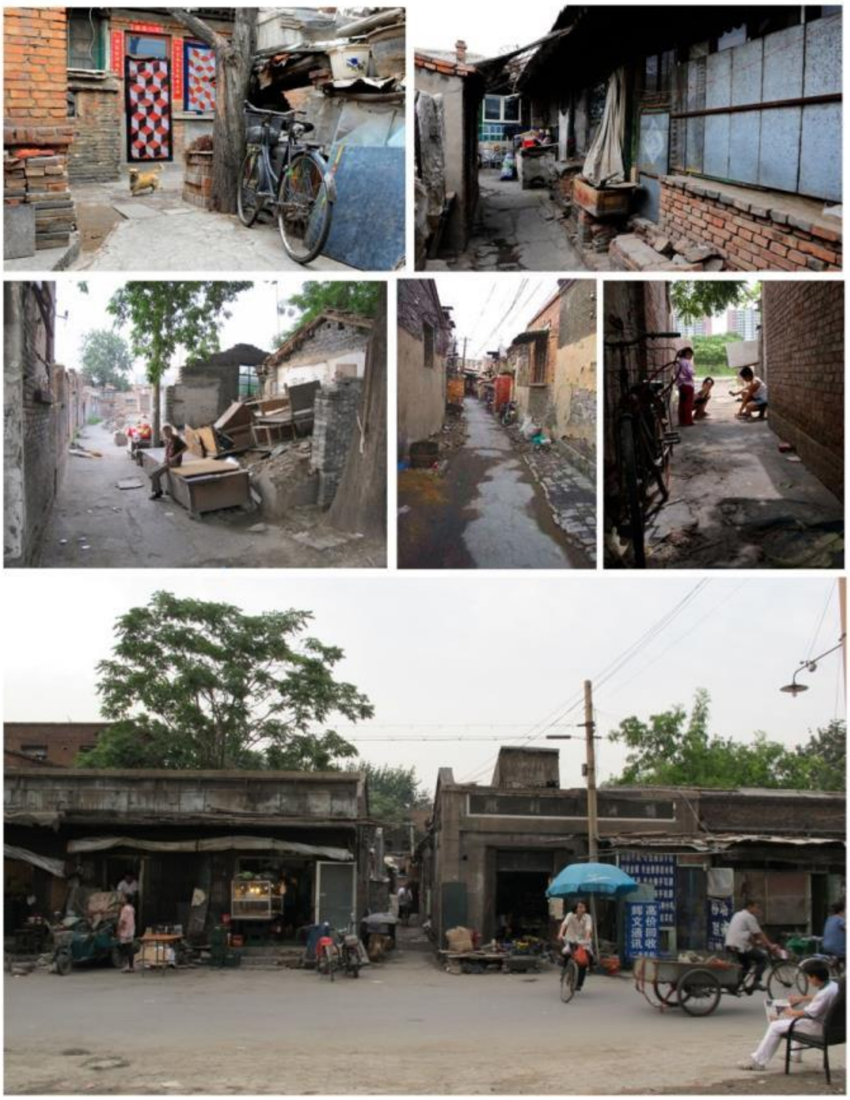


Figure 4- 13 the Decline of the Courtyard Houses in inner city of Tianjin

Top two: the low quality buildings occupied the courtyard; Middle three: the internal streets (HuTong and Xiang) were lack of infrastructure and maintenance; Bottom: the surrounding urban roads were chaos and dilapidated. Source: photos taken by the author in Tianjin

In Tianjin, with the large-scale urban regeneration, the majority of the *Fang*s, *HuTongs* and courtyard houses have been demolished, and redeveloped into archaistic commercial streets and modern housing estates. As the example of the Old Town of Tianjin showed in Figure 4-5, except the road structure and several historical buildings, it is very difficult to find any trace of traditional housing. However, the housing culture and traditions such as the acceptance and adaptation of the collective life, the preference of north-south orientation, and the attention to yard and landscape, deeply influenced the people's experiences and perceptions of residential environment.

4.4.2 The Westernized urban settlement: urban blocks and townhouses

After the Second Opium War in 1860, Tianjin became the largest treaty port in North China, with self-contained concessions established by eight countries. The western capitalistic forces began to encroach upon the Chinese territory. In these leased territories (eight in all), the foreigners were not only allowed to carry out business but also permitted to build up their settlements. These concessions were like independent states, planned and designed according to their own regulations and cultural traditions, which prompted the Western urban structures and lifestyles to be embedded into the indigenous urban environment (Figure 4-14).

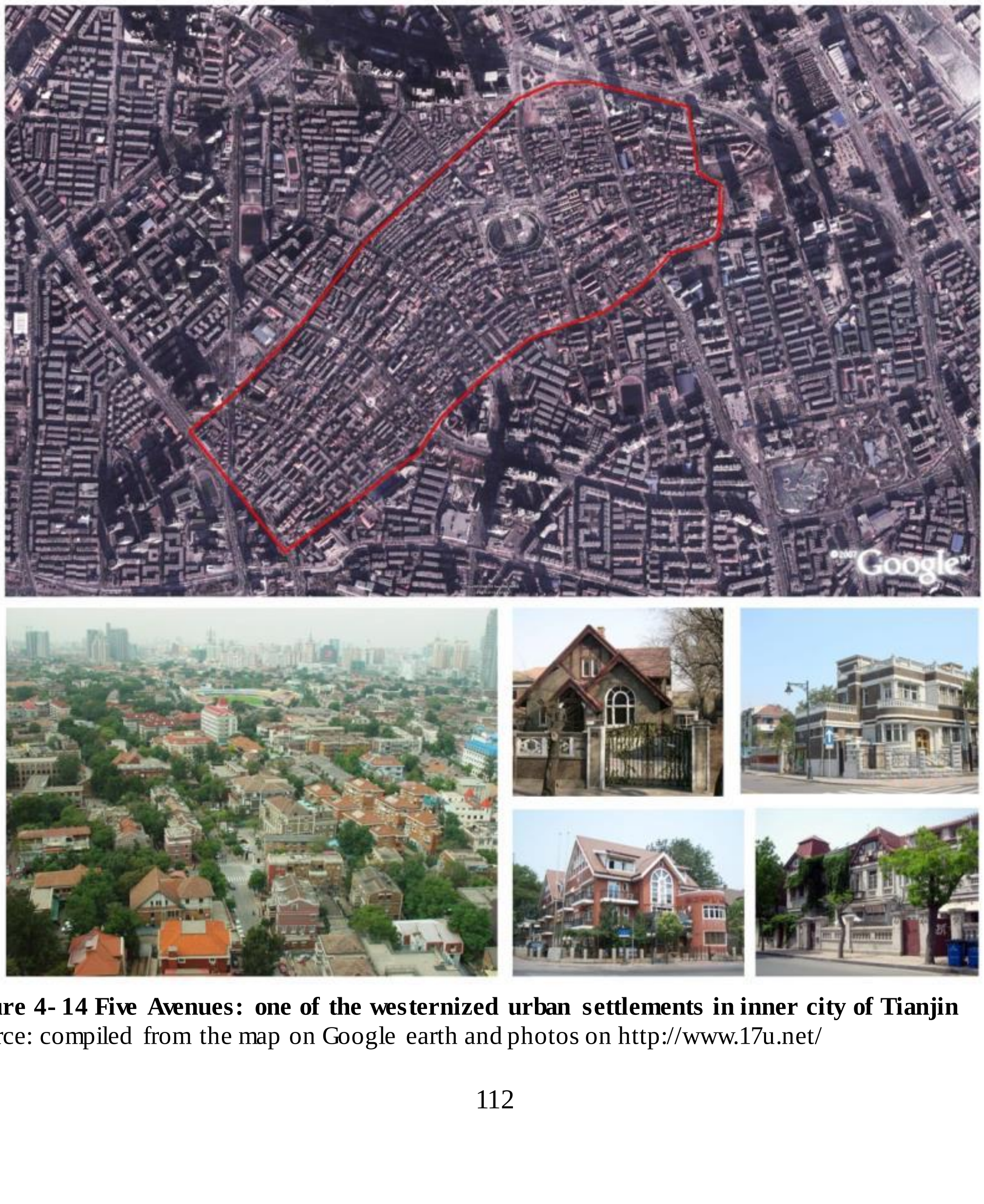


Figure 4- 14 Five Avenues: one of the westernized urban settlements in inner city of Tianjin
Source: compiled from the map on Google earth and photos on http://www.17u.net/

From the perspective of spatial organization and architectural form, the Western urban housing was significantly different from the Chinese traditional settlements. Compared to the large scale of *Fang* and *Xiang* (*HuTong*), the Western street-block structures were smaller and finer, which formed the more intensive road network. The 3- and 4-storey terraced houses with smaller courtyards and detached / semi-detached garden houses replaced the low-rise courtyard houses along the narrow streets. The low fences and walls defined the boundaries between the semi-open gardens and the urban streets, rather than the closed high walls of the courtyard houses. Some of the units facing the streets, especially the ground floor, were open to the public spaces and often transformed into commercial or other uses.

With the establishment of Socialism in 1949, the westernized houses became state-owned properties and were divided into small dwelling units to be allocated to the citizens. Some of the large houses along the main streets were transformed into offices and commercial buildings. After the Reform and Opening in 1978, the local government and scholars began to show interests on the historical and cultural value of the westernized houses, and made effective policies to preserve both urban spaces and buildings. The majority of the houses that had been transformed and occupied by many families were restored to its original look, and the whole concession area became a historic conservation area and a famous tourist attraction. The large-scale urban regeneration since 2003 further improved the infrastructure and landscape of these areas, and many high-incomers bought the old houses -- a process of gentrification has begun (Wang and Zhang 2007).

4.4.3 The Soviet-style urban settlement: work units and residential quarters

The evolution of Soviet-style urban settlements can be divided into two stages: the first stage was between 1949 and 1978, when the Socialist political ideology dominated housing planning and design; the second stage was between 1979 and 1992, when the Reform and Opening-up promoted the transition from the completely planned economy to the so-called Planned Commodity Economy based on public ownership.

Stage 1: the sleep-type and subsistence-type housing planning and design

Between 1949 and 1978, the urbanization process in China was dominated by a Socialist political framework and a highly centralised planned economic system, which was deeply influenced by the former Soviet Union, from whom the urban planning and architecture design system was almost entirely copied (Dong 2004). On the one hand, according to the Socialist ideology, the major function of cities was industrial production. Thus the key goal of urban planning and design was to achieve higher production efficiency. On the other hand, the work unit that integrated both working and living function became the best model for a Socialist city as it was believed that the people's essential demands of living were guaranteed by the welfare system of the state and enterprises including housing, health care, and education (Figure 4-15).

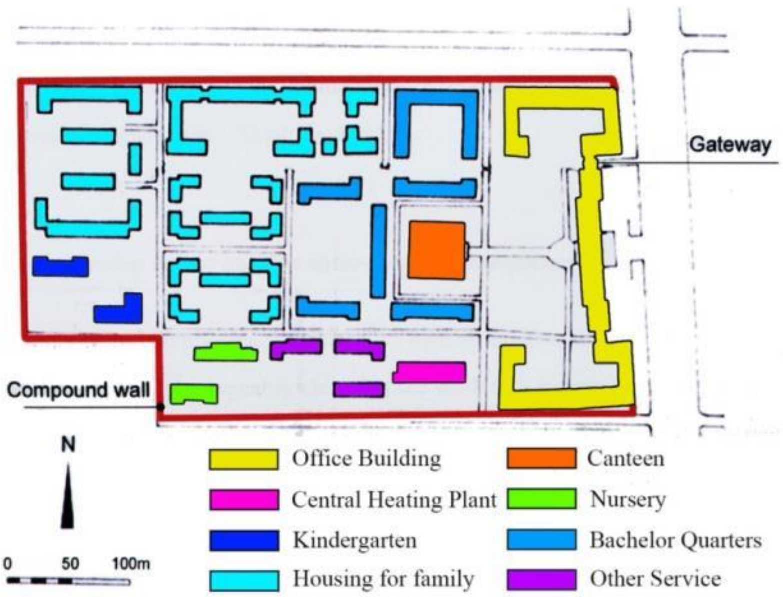


Figure 4- 15 Plan Layout of a Typical Work Unit

Source: compiled from the book: Reconstruct China: 30 Years of Urban Planning, 1949-1978 (Hua 2006)

According to the scale of work units, different levels of service facilities were planned and built, all of which were based on the self-contained pattern, with walls and guarded gates to protect internal resources and facilities (Lu 1998). Moreover, due to the close relationship between working and living, the social relations between members were very close. Meanwhile, the diversity of workers and their family members in terms of age and gender formed a high level of social mix.

However, the mainstay ideology 'production first, livelihood second' resulted in the ignorance of the residential environment quality. Although the housing welfare system had been established to allocate dwelling to each household, the housing standard was very basic and low (Figure 4-16). Many households had been distributed only one bedroom with shared toilet and bathroom among neighbours. No kitchen was designed for work unit housing, as meals were provided in the canteens of work units (Zhang and Wang 2001). With the economic development, the governments and the state-owned enterprises began to invest more money to build better housing for workers.

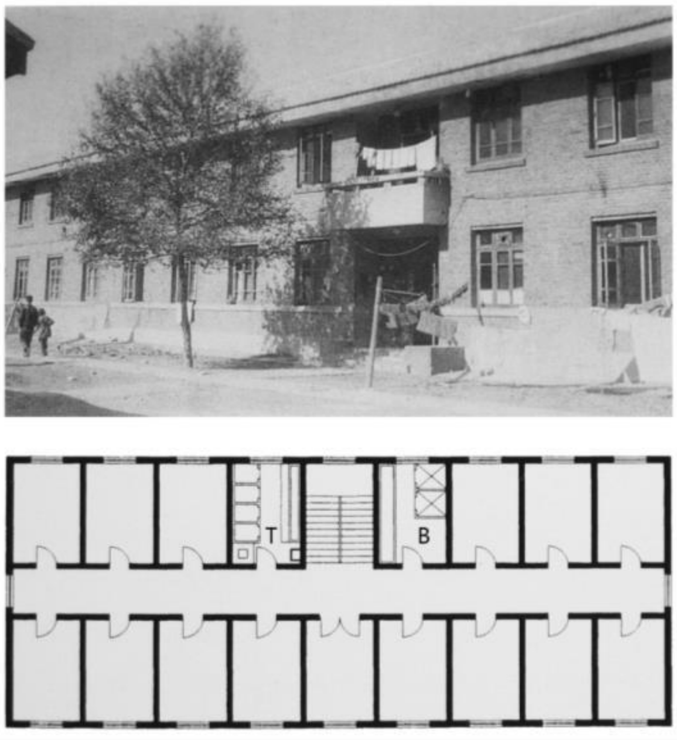


Figure 4- 16 the Earliest Housing Project for Industrial Workers in 1950s

Source: compiled from the book: Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

The residential quarters became a more effective housing solution than the distributed dwelling buildings in the work units. Based on the ideology -- 'everything serves the production', the standardized housing design was introduced from the former Soviet Union in order to enhance efficiency and save cost (Hua 2006). The residential unit became the most fundamental 'cell' of housing design and construction. '*A unit was to be designed with standard components conforming to a construction module. Various combinations of such standard units were to form different buildings, and when the different buildings were put together, they formed residential areas* (Zhang and Wang 2001,p125).' Under the guidance of the extremely rationalism housing planning and design principles, a great number of standardized residential quarters began to be constructed in order to meet the housing shortage just like many European countries have done after the Second World War (Dong 2004). In the majority of large cities and provinces, the local governments established their standard design institutions in 1959, and organized the experts to draw up the standard design atlases that could be directly copied and used to carry out housing developments (Figure 4-17).

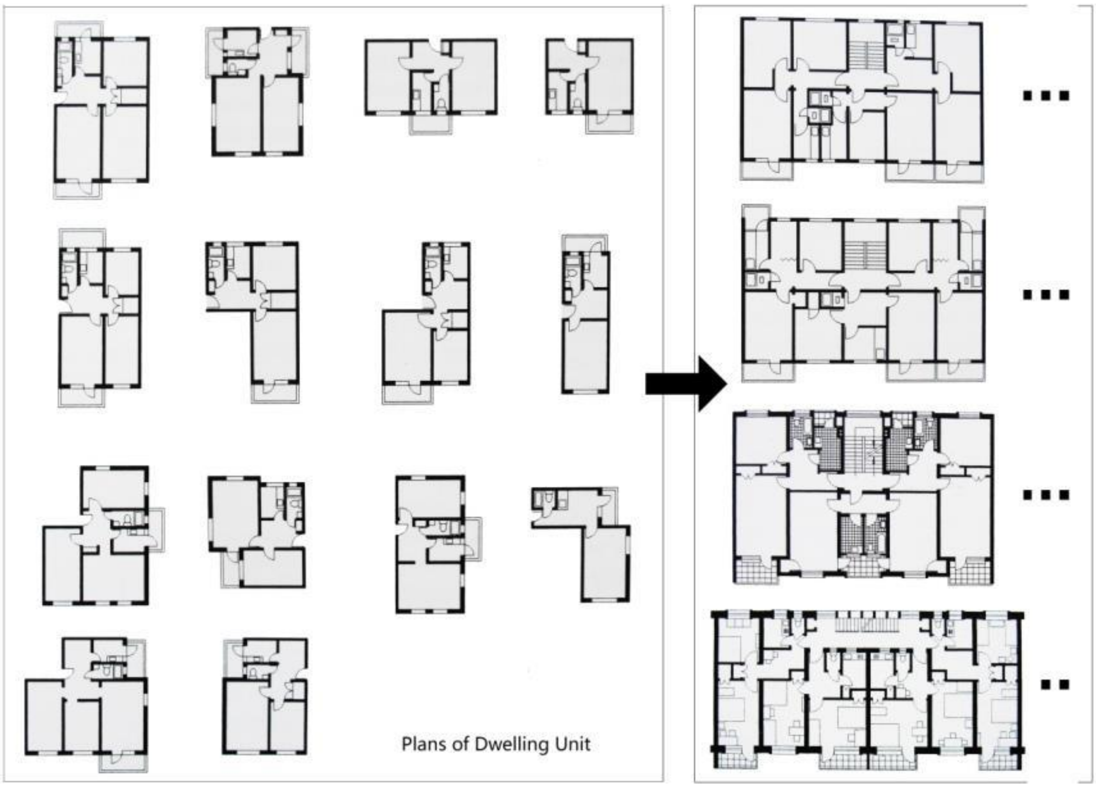


Figure 4- 17 Plans of Standard Housing Designs in Tianjin and Various Combinations

Source: compiled from the book: Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

The standard housing designs usually adopted the compact layouts and the economic sizes in order to reduce construction cost. Bedrooms were the core functional space; both kitchen and bathroom were very small and basic, while living and dining rooms were integrated into a small transitive space without window and natural lighting, which reflected the contempt of the families' living needs in the Socialist ideology (Zhang and Wang 2001).

In terms of the design of dwelling building and the planning of residential quarter, two different styles: the perimeter block layout and the north-south row-housing layout were generated. The former was a key component of many European cities, and was promoted by officials for ideological reasons such as 'Learning from Red Soviet' (Dong 2004). In this type of residential areas, dwelling buildings were usually arranged along the streets, directly facing the streets with either north-south or east-west orientation and surrounding a central semi-private space (Figure 4-18).

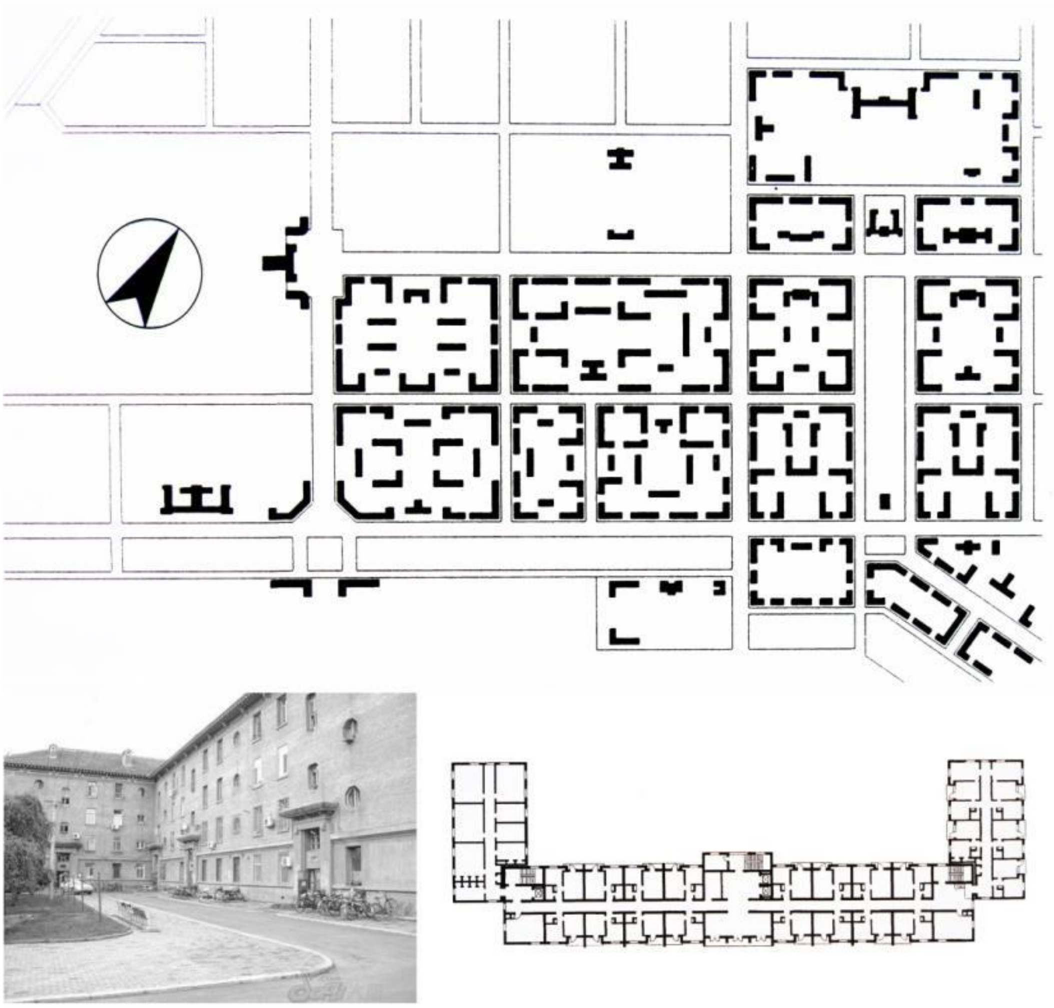


Figure 4-18 Plan and Design of the Perimeter Blocks in the Residential Area
Source: compiled from the photos on http://oldbbs.dongfeng.net/viewthread.php?tid=551716&extra=page%3D5 and the book: Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

Although the perimeter block layout could contribute to higher development intensity, spatial integration, street activities, and strong sense of order and formalism, its unsuitability for China's geography, climate and environment, as well as to the people's living traditions and habits, was soon found. The principal criticisms of the Soviet-style residential quarters were the annoying noise and air pollution of traffic on the streets and the poor natural sunlight and ventilation of those houses facing west or east (Zhang and Wang 2001). Consequently, the perimeter block was gradually replaced by the north-south row-housing layout with the sides of dwelling buildings faceing the streets and their main facades facing south. During the Culture Revolution (1966 – 1976), the ultra-leftist ideology diminished personal territory and simplified housing plan to a monotonous pattern of parallel slab dwelling buildings. During this period, the aesthetics aspects of architecture were completely discounted, and the outdoor environment was dull, simple and crude (Figure 4-19). As Zhang and Wang (2001,p208) pointed: 'all residential areas in China looked very much alike, disregarding local conditions and differences between the north and the south.'

Figure 4- 19 Monotonous Rows of the North-South Slab Dwelling Buildings in the Residential Area
Source: compiled from the books: Reconstruct China: 30 Years of Urban Planning, 1949-1978 (Hua 2006) and Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

Stage 2: the comfort-type housing planning and design

With the end of the Cultural Revolution and the beginning of Reform and Open-up in 1979, restoration of the urban economic restructure became the core task. (Liu and Shao 2001). The welfare housing system began to be gradually reformed into the commodity housing system, and the real estate industry rapidly developed. Housing planning and design started to focus on improving the quality of residential environment, and paid more attention to people's needs. Based on the understanding of the relationships between neighbours, a new concept of housing clusters was generated as the basic planning unit of residential quarters to organize space. Some studies indicated that most frequent communication between neighbours and resident activities occur within housing clusters, which is beneficial to the general psychological welfare of residents and the management of residential quarters (Liu and Shao 2001). Generally speaking, a housing cluster usually consists of about 500 households and is defined by the internal roads within residential quarter. This planning ideology soon formed a standardized layout pattern of residential quarter, nick-named ‘four dishes and one soup’, meaning four housing clusters surrounding a public open space to constitute a residential quarter with an area of between 10 to 20 hectares (Figure 4-20).

Figure 4- 20 Master Plan of an Experimental Residential Quarter in Tianjin

The whole residential quarter was divided into 4 housing clusters around a central park, and each cluster has its own character: the left top one was mainly consisted of terraced garden housing; the left middle one was a series of connected freestanding multi-level point dwelling buildings with platforms forming elevated streets; the bottom one was arranged seven slab dwelling buildings around six point apartments and community centre; the middle one was comprised of land-saving tower blocks.
Source: compiled from the book: Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

Different from the traditional sleep-type and subsistence-type houses, the demand-oriented housing development paid more attention to the improvement of dwelling-unit standards (Figure 4-21). According to the State's policy of housing industrialization, in order to provide comfortable housing, five basic needs: excellent habitability, comfortableness, safety, durability and economy, had to be satisfied (Liu and Shao 2001). The spacious living room with sufficient natural sunlight and attractive view gradually substituted the bedroom to become the core family space, which reflected the return of secular livelihood from socialist doctrine. The standard equipment, size and layout of kitchen and bathroom were more practical, and the coal stoves for cooking and heating were replaced by gas or electric cooker and central heating system. The new techniques and materials including new structures, heat preservation and insulation, and energy-saving windows began to be widely used in housing development. Moreover, better and more reliable elevator technologies promoted high-rise housing development.

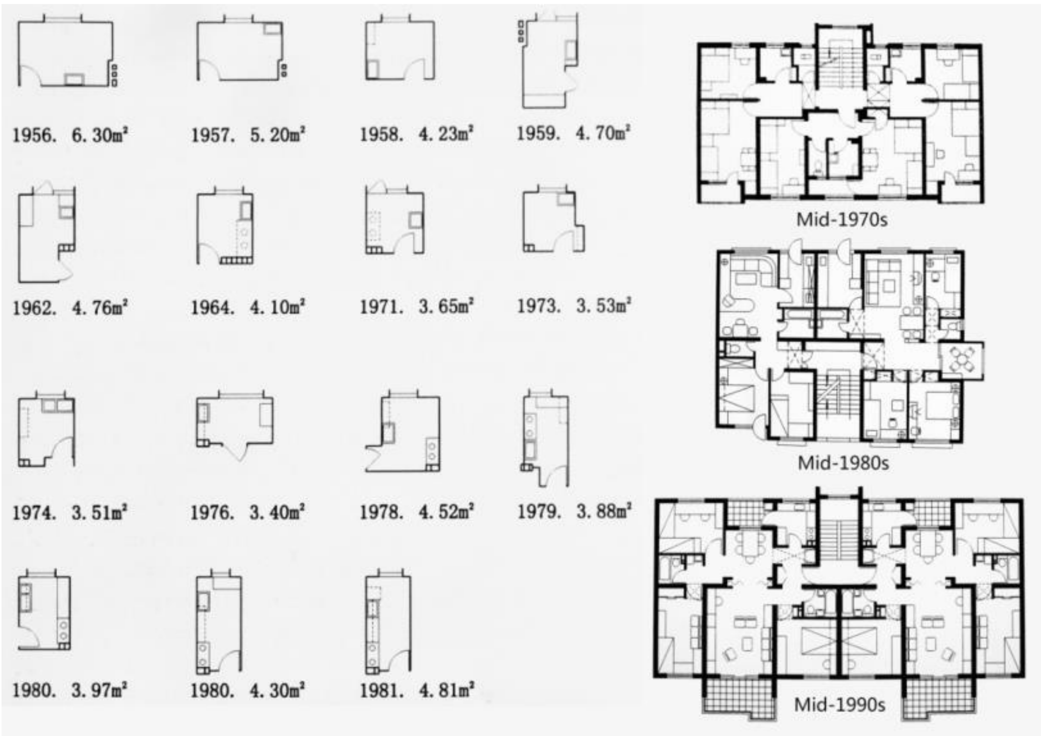


Figure 4- 21 Comparison of Designs for Kitchens and Dwelling Units from Subsistence-type to Comfortable Housing

Left: evolution of layout and equipment of kitchen from mid-1950s to early 1980s: only basin and coal stove were equipped before mid-1960s; cook stove and embedded smoke funnel began to be used since mid-1960s; cooker and kitchen range appeared in 1908s; Right: development of designs of dwelling unit from mid-1970s to mid-1990s: sleep-type and subsistence-type dwelling units in mid-1970s; bigger kitchen and separated living room facing north in mid-1980s; two bathrooms, separated dining room and large living room with balcony facing south in mid-1990s.

Source: compiled from the book: Modern Urban Housing in China, 1840-2000 (Zhang and Wang 2001)

The decline of Soviet-style work units and residential quarters in Tianjin

As Liu and Shao (2001,p190) pointed: '*Housing development reflects both social progress and economic growth, as well as changes and contradictions caused by the redistribution of social interests during reform and the period of opening-up*'. Beginning in 1992, China entered a transformation period from the planned economy to a quasi-market economy. On the one hand, due to the termination of Socialist planning economy, the work unit as an unique social organization lost the basis of the presence and development (Lu 1998). People and resources can freely flow according to the needs of the market. On the other hand, facing the fierce market competition, the work unit as a production division was gradually eliminated because of its low efficiency. Correspondingly, a housing security system was gradually established to replace the welfare housing system Through user-centred planning and design, higher-quality construction, comprehensive development integrating public facilities, and property management, the functional, environmental and service quality of the market-oriented housing estates were significant higher than those of Soviet-style work units and residential quarters. The decline had led to their mass demolition and redevelopment during the process of urban regeneration. The small remnant degraded to low-income and migrant worker tenements (Zhang 2005).

4.4.4 The Hong-Kong-style urban settlement: high-rise housing estates

China's urban housing reform has been going through such a process from an unitary welfare housing system to a multi-layered housing system that consisted of high-priced market-rate housing for middle- and high-income earners; economical and functional housing for middle- and low-income earners; and low-rent housing for the lowest-income earners, which was largely inspired and influenced by Hong Kong's housing system (Liu and Shao 2001). As is in Hong Kong, all land in China is owned by the State, and construction land can only be leased and allocated by the local and central governments (NPCC 1986). For urban residential land, based on the provisions stipulated in the 'Regulations on Assignment and Transfer of State-owned Land in Urban (1990)', the maximum term for transfer of a land-use right is seventy years. The 'Regulations' also stipulated that the total sum of the 70-year land rent needs to be paid upfront any real estate development. The land for affordable housing can be leased at a relatively low price or even assigned to developers by the local government. As a result, the local government not only monopolizes the land resource, but also controls the process of housing development through administrative examination and charges. '*Typically, the collection of taxes and fees accompanied the whole process of real estate development and included eleven payments during site clearance, eighteen payments during application for development approval, six payments during construction and a further eighteen payments during the actual sale of property* (Liu and Shao 2001,p262). Consequently, the financial and technical threshold of housing development rapidly increased, and the real estate developers with good relation with government officials eventually monopolized the housing market. After the tax-sharing reform in 1994, the central government gains large proportions of taxes, and the local governments were forced to depend on the revenue of transferring land-use rights to maintain the local fiscal expenditure, which is generally known as local 'land finance' (Cao, Feng et al. 2008). Under this circumstance, the local government and developers had formed a coalition based on common interests. On the one hand, because of the low rate of return, local governments and developers were unwilling to invest in the development of affordable housing (public housing like Hong Kong and Singapore); on the other hand, they were much keener on developing up-market commercial housing. As a result, a profit-oriented development pattern began to dominate the housing system. Accordingly, housing development intensity continues to rise during the urban regeneration of the high-density urban areas especially in inner cities, and high-rise housing estates inevitably become the dominant housing type.

In fact, the development of high-rise housing had another policy backing since the early 1970s, as a policy was stipulated by the central government to protect arable land and to promote high-rise urban housing in large cities (Hua 2006). However, because of the high cost and high construction requirements, high-rise housing have not become the main housing type until the end of 1990s. Moreover, many professionals believed that the aim of saving urban land could be achieved by making improvements to multi-level dwelling buildings, such as increasing building depth, reducing the ceiling height of each floor, and increasing the quantity of dwelling buildings facing the east and west, which generated prominent influences on Chinese urban housing planning and design (Zhang and Wang 2001).

The construction of high-rise buildings also has a significant impact on the traditional cityscape, especially for a city with a long history. Thus local governments adopted a cautious attitude towards high-rise housing development and stipulated regulations to control high-rise housing construction in the late 1980s (Liu and Shao 2001). Under this circumstance, high-rise housing were used as a planning element to enrich the skyline and space layout of residential quarters, and were considered as the modern apartments with elevators and wonderful views. During this period, the two main forms of high-rise housing: slab and tower high-rise housing, experienced substantial development.

In general terms, slab high-rise housing is defined that, the building width is over two times of its depth and is larger than its height; conversely, tower high-rise housing means that both the building width and depth are smaller than its height.

Slab high-rise housing generated three design typologies, namely: duplex high-rise apartments, external gallery high-rise dwelling building and internal gallery high-rise dwelling building (Figure 4-22). Tower high-rise housing gradually evolved into mainly four design typologies: Y-shaped plans, cross-shaped plans, #-shaped plans, and butterfly-shaped plans. (Figure 4-23). Because of high construction costs and expensive service equipment such as elevators and water supply systems, both slab and tower high-rise housing adopted the high household-density plans that comprised six or more dwelling units per floor with shared public facilities and communal spaces. The high-density layout inevitably results in some of dwelling units facing the east, the west or the north with insufficient sunlight and poor natural cross-ventilation. Higher household density also brought about the decline of privacy and the intensive use of service facilities such as elevators, which is accompanied by either high maintenance cost or frequent disorders. The problematic lifts and infrastructure further impacted the reputation of high-rise housing. The disadvantages of the early high-rise housing soon were indicated by both residents and professionals, which contributed to the reduction of high-rise housing development before the end of 1990s when the market-oriented housing system was established. Property prices rapidly increased to bear expensive facilities and the relatively low-density high-rise housing.

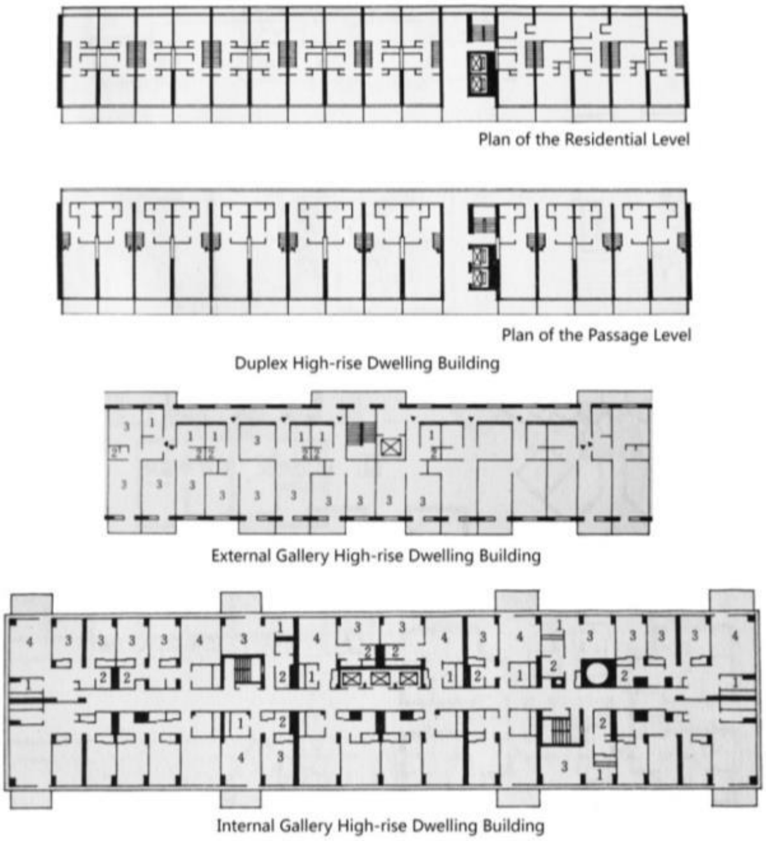


Figure 4- 22 Plan Types of Slab High-rise Housing

Source: compiled from the book: Architecture Design Data (1990)

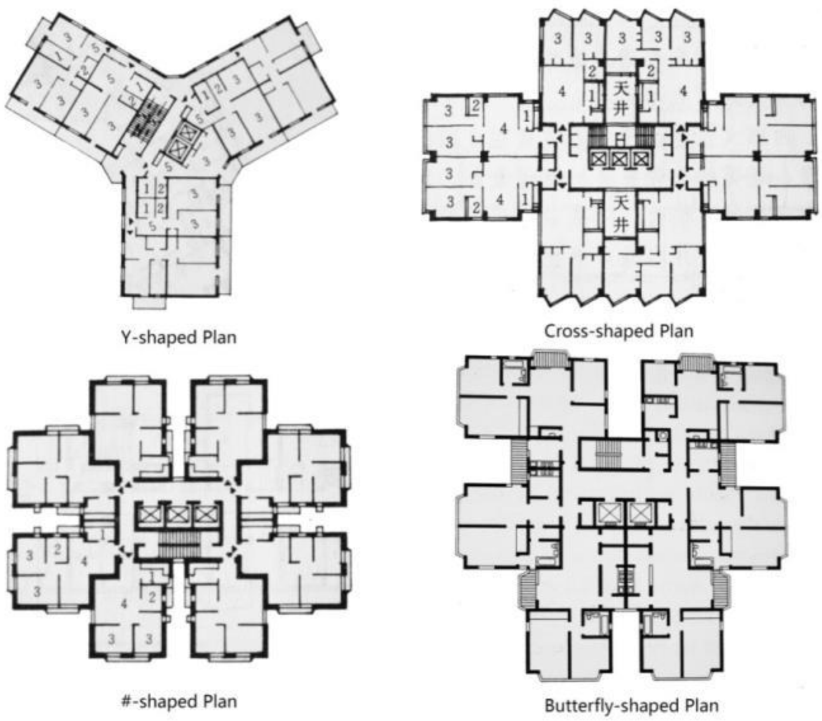


Figure 4- 23 Plan Types of Tower High-rise Housing

Source: compiled from the book: Architecture Design Data (1990)

The year 1999 saw the end of housing distribution under the old welfare system. Real estate developers began to monopolize the market of new housing development. The profit-oriented housing development pattern encouraged developers to pursue higher land revenue, which further caused housing estates to be built denser and higher. Further, the urban landscape consisting of tall modern buildings was considered the symbol of prosperity and development, thus the local governments encouraged high-rise housing development.

Based on the existing urban structure of ‘super-block and wide-avenues’ and the closed spatial pattern of both Chinese traditional housing and Soviet-style residential quarters, new high-rise housing estates formed large-scale gated communities managed and maintained by estate management companies. Meanwhile, the urban neighbourhoods, in which these new gated communities are located in, are slow in improvement and even overlooked in the process of urban renewal. As a response, the new gated high-rise housing estates would look to integrate living functions with public service facilities, infrastructure facilities and even transport facilities to cater to the needs of their prestigious residents who could afford the cost. Consequently, this pattern of development and management further reinforced the significance of housing estates and contributed to a process of gentrification in the inner city.

Moreover, as revealed in section 4.4.1, the housing culture and climatic condition of China formed a widely-accepted preference of south orientation, which deeply impacted housing layout, planning of residential area and even urban spatial structure. In practice, north-south orientation is an effective sustainable design strategy that can optimize natural lighting and ventilation, and avoid western exposure in the climate of North China (Zhu and Lin 2004). Correspondingly, the detailed provisions, such as insolation interval, ventilation interval, hygienic interval, and interval of fire prevention, have been formulated to control building spacing in order to guarantee environmental quality and safety in codes of housing planning and design (CAUPD 2002, CADRI 2011). Moreover, in spite of housing reform from welfare housing system to market-oriented housing system, the codes and regulations of housing planning and design in China still continued certain socialism and equalitarianism provisions, such as mandatory requirement of direct sun-lighting of all dwelling units. More importantly, Tianjin is located in the North China plain seismic zone that is a region with seismic fortification intensity of 7 degrees, which impacts the building spacing and form of high-rise housing. All of these factors combined together to form the standardized planning layout of high-rise housing estates, that dwelling buildings were arranged in parallel rows with north-south orientation in order to minimize cost and maximize profits, while meeting the regulations on safety and sun-lighting.

Because insolation interval of high-rise buildings is much larger than the other spacing requirements, insolation interval, among all the regulations on building spacing, became the most important controlling factor that can directly impact the development intensity and planning layout of high-rise housing estates. The national regulation of insolation interval is to guarantee that at least one living space (bedroom or living room) of each dwelling unit can receive more than two hours' direct sun-lighting in newly developed urban area and more than one hours' direct sun-lighting in renewal urban area between 8 am to 4 pm in the 20th or 21st of January called Great Cold Day that is the 24th Solar Term in China (CAUPD 2002, CADRI 2011). However, before the new Tianjin Insolation Analysis Technology Management Interim Provisions (TPB 2008) was implemented in 2008, the local regulation of Tianjin was below the national standard.

Table 4-3 Comparison of Tianjin Local Regulations and National Regulations of Insolation Interval

		Multi-storey Residential Building			High-rise Residential Building	
		North-south	Deflection angle		North-south	West-east
Old local regulations of Tianjin before 2008	New urban area	1.5H①	South 15-30°	1.3H①	1.2W②	1.0W②
			South > 30 °	1.0H①		
	Renewal urban area	1.2H①	South 15-30°	1.1H①	1.0W② and > 14m	0.8W② and > 14m
			South > 30 °	1.0H①		
New local regulations of Tianjin after 2008	New urban area	1.61H①	Reduction coefficient: 1-0.95		Insolation analysis③ 1.2W② and > 14m	Insolation analysis③ 1.0W② and > 14m
	Renewal urban area	1.5H①			Insolation analysis③ 1.0W② and > 14m	Insolation analysis③ 0.8W② and > 14m
National regulations	New urban area	2 hours sun-lighting④	Reduction coefficient: 1-0.95		2 hours sun-lighting④	2 hours sun-lighting④
	Renewal urban area	1 hour sun-lighting④			1 hour sun-lighting④	1 hour sun-lighting④

①H: Height of building = Height from the windowsill of ground floor to the cornice of building.
②W: Width of building = Projected width on the south
③Insolation analysis: it is a standard method of software simulation to analyze whether sun-lighting of each dwelling unit can meet the national regulation.
④the length of time of direct sun-lighting in the Great Cold Day that is the 24th Solar Term in China (20th or 21st of January)

As Table 4-3 showed, the simplified formula of insolation interval based on building form and orientation was used to control building spacing in Urban Planning and

Management Technical Provisions of Tianjin (TCMC 1995) and Design Standard of Tianjin Urban Residential Buildings (TCMC 2007), which significantly influenced the planning and design of high-rise housing estates.

In the planning and design of high-rise housing estates in Tianjin, the insolation interval was controlled by two types of standards based on the two building forms – slab and tower high-rise housing. As mentioned in section 4.4.3, before the establishment of market-oriented housing system, the property prices were stable at a low level for a long time. Meanwhile, due to high construction cost and expensive equipment including elevator and water supply system, the early slab and tower high-rise housing had to increase the household density and the number of dwelling units per floor to reduce the unit cost, especially for welfare housing (See Figure 4-22 and 4-23). With the rapid development of the commercial housing market, a new type of slab high-rise housing was designed, that was basically a combination of several small slab high-rise building units of lower household density. Each building unit has its own entrance and circulation core shared by three or less households (Figure 4-24).

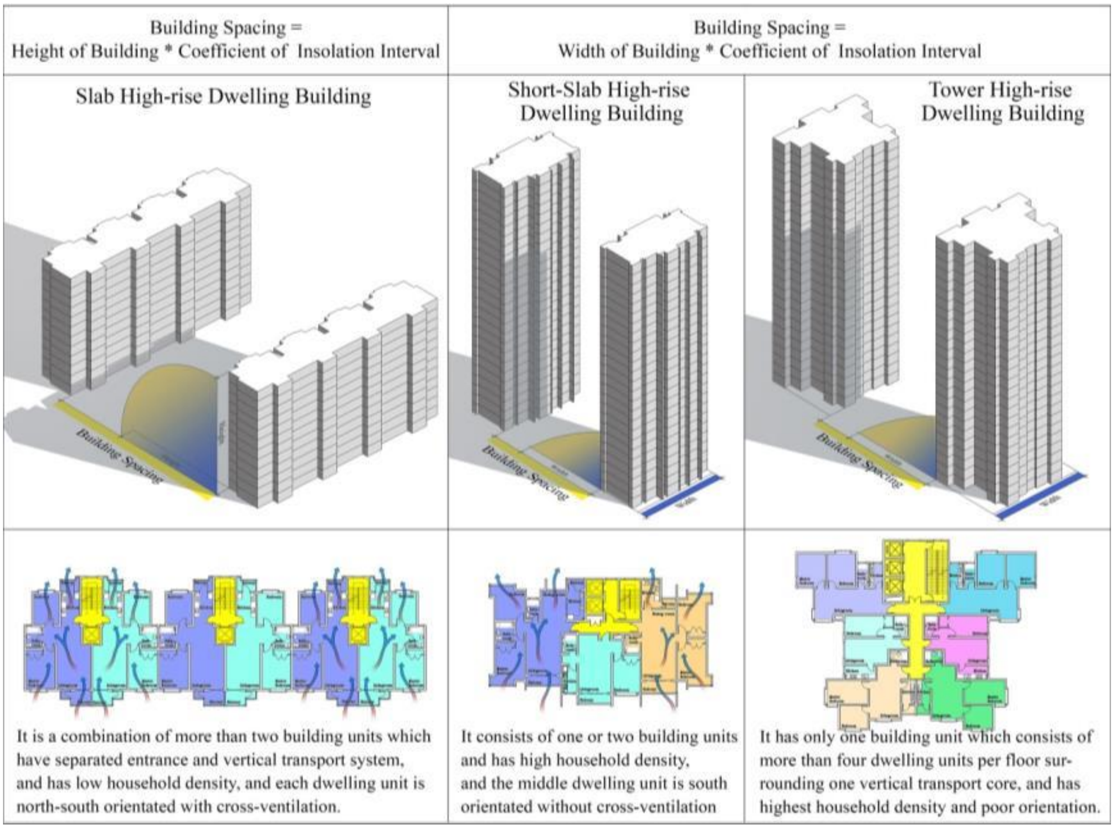


Figure 4- 24 Three Dominant High-rise Dwelling Building Forms in Tianjin

This design achieved a good balance between high overall household density and low service infrastructure intensity, as well as effectively improved the residential environment in terms of both physical and psycho-social dimensions. The unit-type slab high-rise housing with relatively low density and more comfortable environment quickly became a popular housing form in many Chinese cities.

In the pursuit to achieve higher development density, the tower high-rise housing was brought under scrutiny. In traditional sense, tower high-rise housing usually consists of more than 4 dwelling units per floor, which allows for higher household density but poor ventilation and day lighting in each dwelling unit. According to the local regulation in Tianjin, the insolation interval of slab high-rise building is equal to the building height multiplied by the coefficient of insolation interval; and the insolation interval of tower high-rise building is equal to building width multiplied by the coefficient of insolation interval. Thus the former cannot be built very high in order to guarantee seismic safety and avoid too large and uneconomic building spacing; on the contrary, the latter can be built relatively higher to achieve high development intensity. Tower high-rise housing can also help create remarkable urban landscape and richer environments of housing estates. Therefore, developers and architects showed preferences of tower high-rise housing. Nonetheless, slab high-rise housing has its own advantages, such as lower household density and better indoor environment of dwelling units in terms of insolation, day lighting and ventilation. Consequently, residents and property buyers generally prefer slab high-rise housing. Under this background, a new type of high-rise housing -- short-slab high-rise housing was born. Short-slab high-rise housing demonstrates the advantages of both slab and tower high-rise housing forms. It adopts similar architectural layout with slab high-rise housing that can achieve lower household density and better indoor environment, while its building form is similar with tower high-rise housing in order to achieve higher development intensity with smaller insolation intervals. Short-slab high-rise housing soon became the most popular high-rise housing form in Tianjin.

Various combinations of the above three types of high-rise dwelling buildings produced four representative forms of high-rise housing estates: *majority slab high-rise housing estate; mixed slab and short-slab high-rise housing estate; majority short-slab high-rise housing estate; and mixed short-slab and tower high-rise housing estate*, which established the practical foundation of a multiple-case study in the following chapters.

4.5 Conclusion

This chapter has achieved the first research objective:

> *To understand the development and evolution of high-rise housing estates in the context of China, and reveal the mechanisms that the macro-context shape high-rise residential environment and form resident' living habits and housing preferences;*

Through the historical analysis, it can be concluded that Tianjin, as a representative large city in North China with a population of over 10 million, has a long history of human settlement, where four major types of urban housing: Chinese traditional urban settlements, westernized urban settlements, Soviet-style urban settlements and Hong-Kong-style urban settlements, constituted the urban residential environment. Especially in the inner city, the rapid increasing population and the profit-oriented housing development pattern promoted the mass construction of Hong-Kong-style high-rise housing estates in the age of market economy under a national policy of Reform and Open-up. Compared to the disrepair traditional courtyard houses, the expensive westernized townhouses, and the low-standard welfare housings, the new market-oriented high-rise housing estates indeed attracted the middle- and high-income class due to their central location, gated community management, careful planning and design. With no doubt, high-rise housing estates have certainly become the dominant housing type in the current urban development of Chinese cities. The housing market dominated by high-rise housing estates did not provide the diversified housing options for the various households.

The macro-context formed the residents' perception of liveable residential environment. The Chinese traditional housing culture and the Socialist life concept formed a collective living habit that brought residents a higher acceptation of high population density. The gated community managed by property companies have become a widely accepted residential pattern. The climatic features (hot summer and cold winter) and traditional housing culture (Confucianism and Daoism) enforced the residents' preference of north-south orientation and indoor cross-ventilation and residents' attention of outdoor landscape and indoor decoration.

As a brand new housing type in China, high-rise housing estates were not only influenced by the development patterns of Hong Kong and Singapore, but was also influenced by the existing urban structure, which is characterised with north-south orientated buildings, wide avenues and large urban blocks. The traditional enclosed urban settlements consisting of three spatial levels: *Fang*, *Xiang* and *Courtyard House*, and the Soviet-style standardized urban settlements based on the Socialist ideologies formed the urban context where high-rise housing estates were developed. Some of the features, such as the cross-ventilated layout of dwelling unit, the north-south orientation of dwelling building, and the enclosed housing estate, have been inherited down by the new high-rise housing estates through the regulations and codes of urban housing planning and design. Finally, during the process of pursuit of higher development intensity, the complicated forces gradually formed four major forms of high-rise housing estates:

majority slab high-rise housing estate;
mixed slab and short-slab high-rise housing estate;
majority short-slab high-rise housing estate; and
mixed short-slab and tower high-rise housing estate,

which constructed the foundation of the multiple-case study in the following chapters.

Chapter five

Qualitative survey: residential environment features and residents' liveability experience of high-rise housing estates

5.1 Introduction

This chapter is focused on answering the second research question:

> *'What are the residential environmental features of high-rise housing estates in the high-density urban areas of China, and what are the residents' liveability experiences of the high-rise residential environment?'*

Firstly, based on the analysis of the planning and design document and development data, the main residential environment features of the four study cases are explored at the four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit. And then, through in-depth site investigations and interviews, the detailed residential environment features and residents' liveability experience and usage conditions of the four study cases are respectively analysed case by case according to the 58 liveability elements. Finally, the findings are summarized and discussed in-depth in order to draw the qualitative conclusions on residential environment features and residents' experiences of the high-rise residential environment.

The site survey included two main qualitative approaches: observation and interview. The site investigation composed of two stages according to the accessibility and ownership of the four spatial levels of high-rise housing estates. Due to the enclosed management pattern of housing estates and the gated entrance of dwelling buildings, the investigation was conducted with permission by both the management bodies and the residents.

At the first stage, the site investigations on the actual performance of the liveability elements at the public and semi-public spatial levels including urban neighbourhood, housing estate, and dwelling buildings, were carried out case by case. The observations were cross-referenced with the analysis of the planning and design documents. Judgement on the liveability strengths and weaknesses were also formed from the professional perspective. Site investigations of each study case were carried out on weekdays and weekends, so that comprehensive conclusions could be made. Photos were taken to record the usage conditions of the residential environment, especially the reformation and regeneration of the built environments that were spontaneously carried out by the residents and management bodies, which could reflect the occupants' real needs of their residential environment.

At the second stage, indoor investigations on the situation of dwelling buildings and dwelling units were carried out within the voluntary respondents' homes. This stage of investigation focused on the usage and performance of the semi-private spaces and facilities such as lobby, lift, corridor and staircase within the dwelling buildings, and the actual conditions of the private spaces and facilities of the dwelling units. The level of management and maintenance of the semi-private spaces and facilities could be reflected by the conditions of the physical environment.

The interview consisted of two stages: preliminary interview and in-depth interview. The former was carried out simultaneously with the questionnaire survey. Questions were asked on the reason for each evaluation the respondents gave in the questionnaire, which could help to collect more detailed information to understand the evaluation mechanism of the residents. At the meantime, some of the respondents could express their opinions and perceptions of high-rise living issues that were not included in the questionnaire. The whole process was named as the preliminary interview.

For those respondents who were willing to participate in the in-depth interview, a face-to-face interview was carried out in their dwelling units simultaneously with the indoor investigation. The semi-structured interview was based on the four spatial levels and 58 liveability elements, and the personal experiences of high-rise residential environment were the core content. As supplement, interviews with the managers of the property management companies were conducted by the author in order to understand the liveability situations from the perspective of management and maintenance, and examine the residents' opinions.

5.2 Residential environmental features of the four study cases in the inner city of Tianjin

In the context of the inner city of Tianjin, as discussed in Chapter 4, different combinations of the three high-rise housing forms produced 4 types of high-rise housing estates: majority slab high-rise housing estate; mixed slab and short-slab high-rise housing estate; majority short-slab high-rise housing estate; and mixed short-slab and tower high-rise housing estate, which are respectively represented by case 1, case 2, Case 3 and Case 4. The 4 research cases are chosen within an area of 1 km^2 in the north part of NanKai District, which is one of the most important redevelopment areas in the inner city of Tianjin (Figure 5-1).

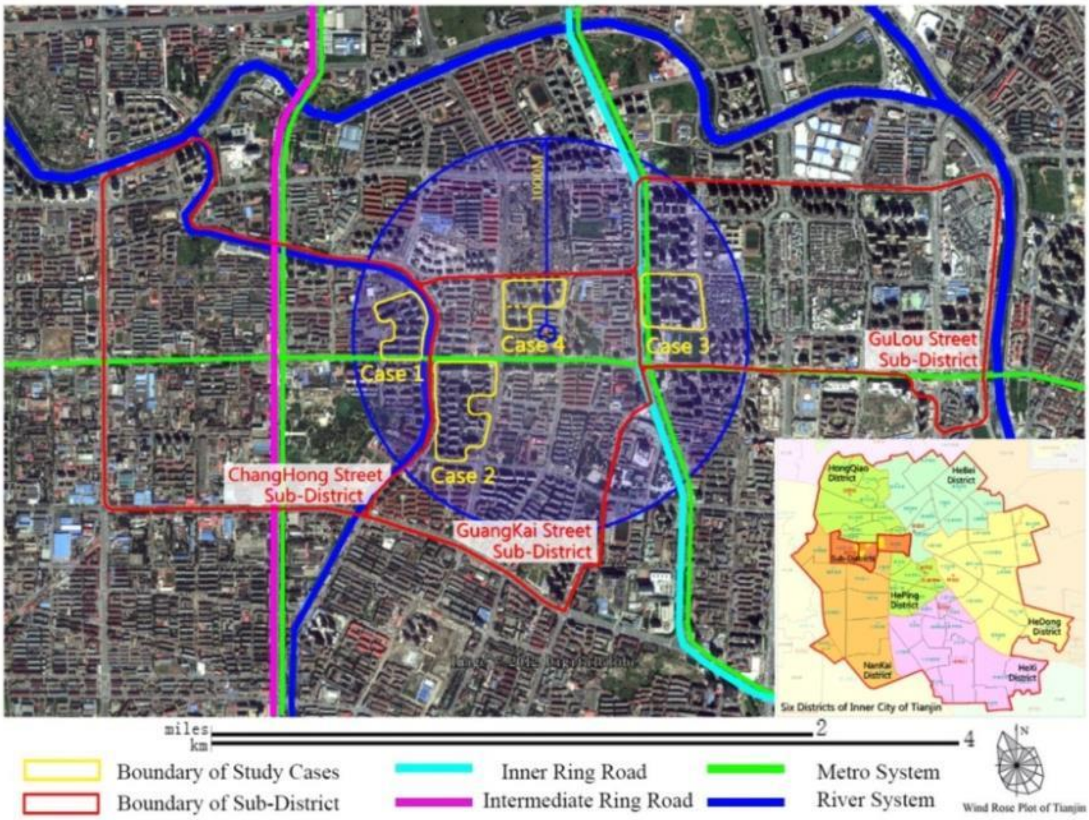


Figure 5- 1 Geographical Location and Administrative Attribution of the Four Study Cases

Source: compiled from the maps on Google Earth (2011) and Tianjin City Master Plan (2005-2020)

As shown in Figure 5-1, Cases 1, 2 and 4 are located between the middle and inner ring roads; Case 3 is located inside of the inner ring road. Three metro lines run through this area, and a convenient public transport system including both metro and bus lines are under development. The Jin River flows through the site between Case 1 and Case 2, which forms a public green space with Changhong Park. Case 3 is located on the west periphery of Tianjin Old Town (GuLou Sub-district), which has a history of 600 years. Tianjin Old Town has been totally demolished except for several remarkable Chinese traditional historical buildings such as the Drum Tower. The Old Town has been redeveloped into a high-density multi-functional area, in which eleven large-scale high-rise housing estates including Case 3 were developed from 2003 to 2011. Case 4 was located on the north boundary and adjacent to a dilapidated Chinese traditional neighbourhood that is dominated by disrepair courtyard houses, which are about to be demolished. Although the 4 research cases are located in the same urban district, their adjacent urban neighbourhoods show different characteristics. The following sections will analyse in detail the features of residential environment of the 4 cases from the four spatial levels: Urban Neighbourhood, Housing Estate, Dwelling Building and Dwelling Unit.

5.2.1 The Urban Neighbourhoods: different degrees of completion of urban regeneration

The urban neighbourhoods where the 4 cases are located are at different degrees of maturation in terms of both physical and social dimensions (Figure 5-2).

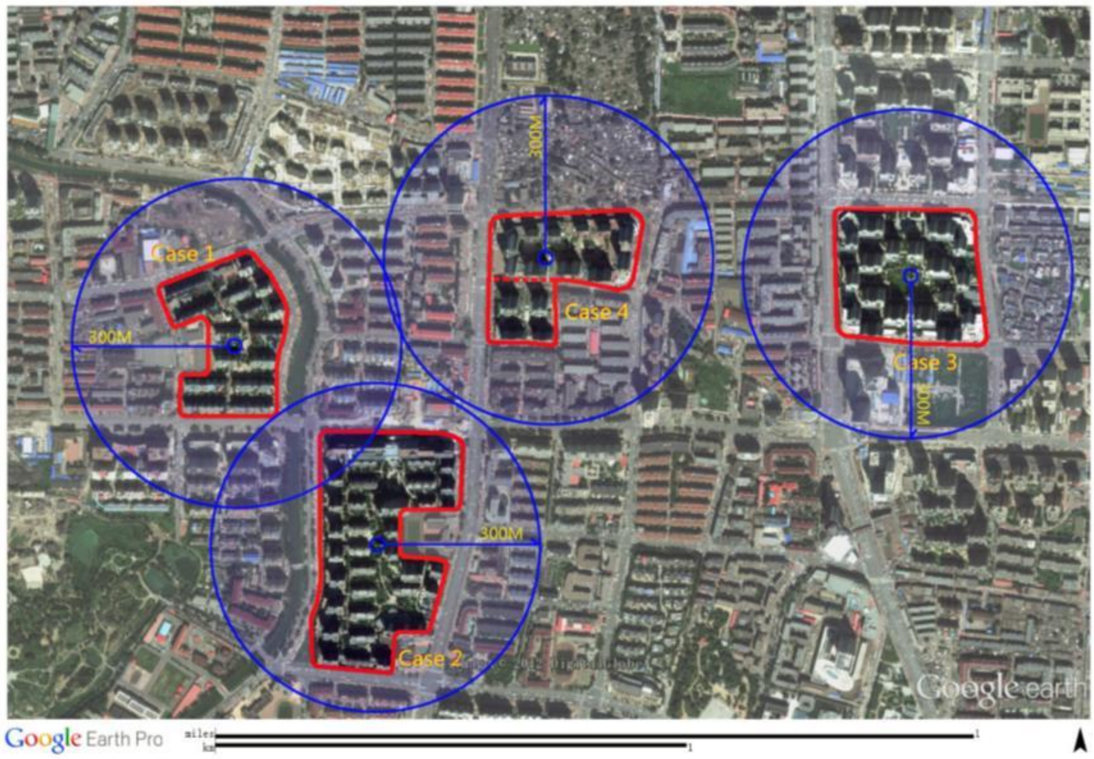


Figure 5- 2 The Urban Neighbourhoods of the four Study Cases

Source: compiled from compiled from the maps on Google Earth (2011)

Cases 1 to 4 were chronologically developed from 2003 to 2008. Although Case 1 was the first to be completed among the 4 cases, the regeneration of its surrounding neighbourhood is still on-going, demonstrating a state of semi-maturity with high maturity of social environment and low maturity of physical environment. On the contrary, the regeneration of the neighbourhood surrounding Case 2 was fully completed in 2007. At the present, the neighbourhood of Case 2 is relatively more mature than those of the other cases. Case 3 is located in the old town centre of Tianjin, which has been completely redeveloped in 2011 and forms a brand new comprehensive urban neighbourhood consisting of commercial, office and residential functions. The neighbourhood of Case 4 is partly redeveloped, and the urban block on its north that belongs to another administrative district has been planned to be demolished and redeveloped. Moreover, two primary schools with high reputation are located in the neighbourhoods of Case 2 and Case 3, which are important selling points of these two estates to property buyers. Except for Case 4, the other three cases have good vicinity to the nursery schools within their neighbourhoods. Case 1 and Case 2 are adjacent to Jin River, which is an important urban landscape, as well as being near a public park (500 metres away).

5.2.2 The Housing Estates: different levels of development intensity, planning and community management

At the spatial level of housing estate, the four research cases respectively represent four typical patterns of planning and design, which have different development intensities and environment features. For high-rise housing estates, according to the Code of Urban Residential Areas Planning & Design (CAUPD 2002), *household density*, *plot ratio* and *building density* are the key indicators to control the development intensity, and the appropriate range of *household density* is between 208 and 312 households per hectare, *plot ratio* should be between 2.0 and 3.5, and net residential *building density* should be less than 20%.

As the development data (Table 5-1) showed, the plot ratio of the studied housing estates increase from 2.13 of Case 1 to 4.09 of Case 4, the development intensity of the four study cases raise one by one. It is worth noting that the development intensity of Case 3 and Case 4 exceed the appropriate range provisioned in the Code of Urban Residential Areas Planning & Design (CAUPD 2002). Among the four cases, Case 1 has the lowest average building height (11.5 storeys), the least parking spaces per household (0.3) and the lowest property service charge; Case 2 has the highest green area ratio (43%) and the lowest household density (184 Households per Hectare); Case 3 has the highest average building height (27.1 storeys) and the highest property service charge; and Case 4 has the highest plot ratio (4.09), the highest household density (403 Households per Hectare) and the lowest green area ratio (30%).

Table 5-1 Development Data of the Study Cases

		Case 1 (ShengDa Garden)	**Case 2** (Style of Spring)	**Case 3** (TianLin Garden)	**Case 4** (BaoLong Bay)
1	Begin of Construction	Nov. 2003	Mar. 2005	Aug. 2006	Sep. 2006
2	Time of Completion	Sep. 2005	Apr. 2007	Oct. 2008	Nov. 2008
3	Land Area of Housing Estate (Ha.)	6.58	9.65	6.08	3.85
4	Residential Floor Area (M^2)	140,350	220,900	238,148	157,650
5	Plot Ratio of Housing Estate	2.13	2.29	3.92	4.09
6	Average Building Height (Storeys)	11.5	12.4	27.1	24.8
7	Building Spacing (Insolation Interval)	1.2H①/ 1.1W②	1.3H①/ 1.2W②	1.2W②	1.2W②
8	Net Residential Building Density (%)	18.5	18.5	14.5	16.5
9	Green Area Ratio (%)	35	43	31	30
10	No. Parking Space per Household	0.3	0.8	1.1	1.1
11	No. Total Parking Spaces	427	1,360	2,029	1,479
12	No. Households	1,276	1,775	1,861	1,552
13	Household Density (Household/Ha.)	194	184	306	403
14	Property Service Charge (RMB/M^2. Month)	1.5	1.8	2.2	1.8

①H: Height of building = Height from the windowsill of ground floor to the cornice of building.
②W: Width of building = Projected width on the south
The exchange rate between the British Pound and the RMB is about 1/10.

Source: compiled from the project archives of Tianjin Planning Bureau, data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Center of Soufun.com Limited

As Figure 5-3 shows, Case 1 consists of twelve 9- to 13-storey slab high-rise dwelling buildings and three 18-storey short-slab high-rise dwelling buildings. The whole estate was enclosed by walls and commercial buildings, and had only three guarded entrances. A mixed-pedestrian-vehicle internal traffic system, which allows pedestrians, cyclists and cars to share the internal roads, was adopted. The leisure spaces and facilities are located in the dispersed gardens between the buildings. Case 1 has the lowest property service charge, which implied relatively lower quality of management and maintenance.

Case 2 comprises sixteen 9- to 24-storey slab high-rise dwelling buildings and seventeen 18- to 26-storey short-slab high-rise dwelling buildings. Case 2 forms a rich and varied internal environment, with continuous commercial and office buildings forming the boundary of the gated community, which also serve to reduce the impact of the external urban noise on the internal environment. Case 2 adopts the pedestrian-vehicle-separated internal traffic system (vehicles cannot enter into the community and must be parked in the centralized parking lots or underground parking lots located in the periphery of the community), that creates a safe and quiet internal environment. A community centre including leisure facilities such as swimming pool, gym, and tennis court, was built near the main entrance. A multi-level landscape system consisting of two Chinese-style central gardens and a set of small green spaces between the buildings create rich and pleasant outdoor spaces. The community management and maintenance are to a high standard with second highest service charge among all cases.

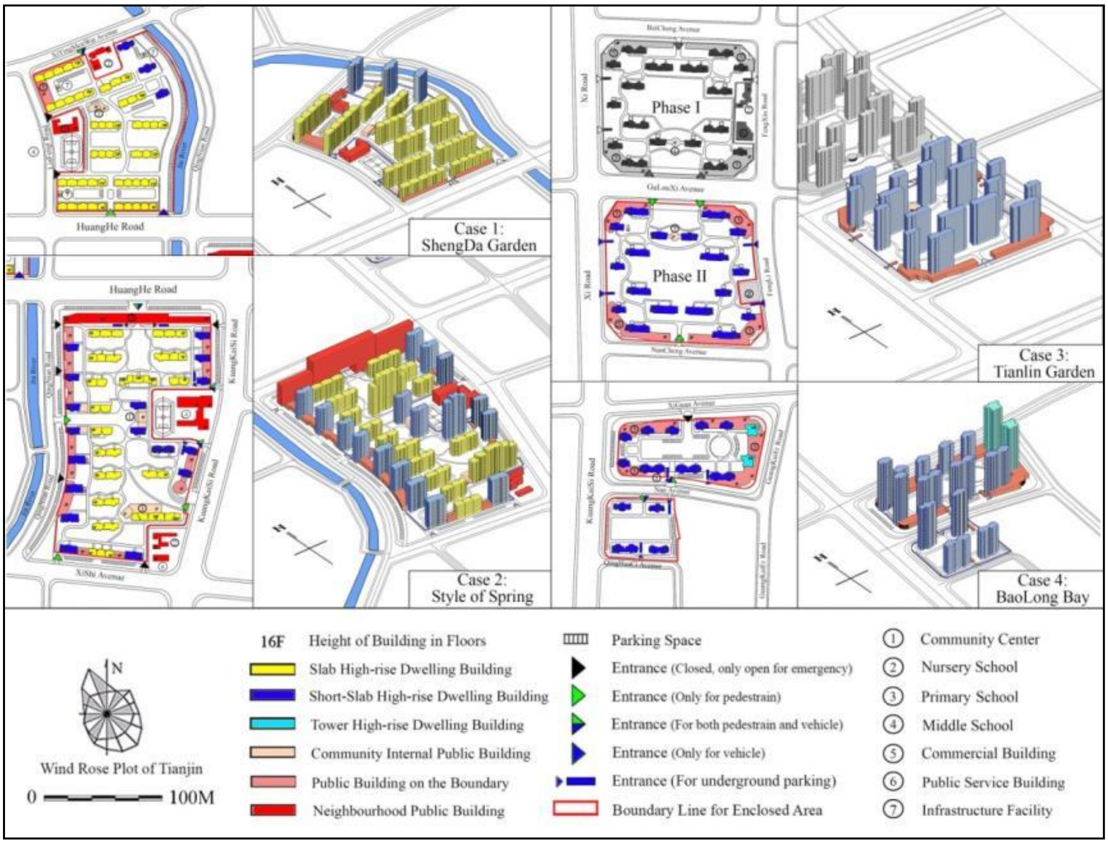


Figure 5- 3 Planning Layout of the Four Study Cases

Case 3 was developed as the second phase of a large-scale housing development that comprised of three separated housing estates developed by the same private developer. It is constituted of eighteen 28-storey short-slab high-rise dwelling buildings that surrounded a large Chinese-style central garden. The whole estate was enclosed by commercial buildings and steel fences with three pedestrian entrances and four vehicle entrances, all of which are monitored. A three-dimensional pedestrian-vehicle-separated internal traffic system has been constructed, with the underground floor for vehicles and the ground floor for pedestrians and cyclists. A multi-functional clubhouse with various leisure facilities was located in the middle of the community, and 4 commercial buildings that combined with dwelling buildings were built on the four corners. With the highest property service charge of all cases, Case 3 enjoys the best community service and management.

Case 4 contains two estates separated by a street, encompassing, as a whole, thirteen 18- to 32-storey short-slab high-rise dwelling buildings and two 32-storey tower high-rise dwelling buildings. The north part was enclosed by two-storey commercial buildings, and the south part was surrounded by steel fences. Like Case 1, a mixed-pedestrian-vehicle internal traffic system has been adopted. In order to satisfy the demands of parking, two centralized underground parking lots have been constructed, with off-street parking spaces distributed surrounding and within the community. The standard and quality of public facilities and landscape are distinctively below the other three cases, despite of requiring the second highest service charge.

5.2.3 The Dwelling Buildings: different form combinations of high-rise dwelling buildings

At the spatial level of dwelling building, the 4 cases have many common characteristics. Despite taking three different building forms: slab, short-slab and tower high-rise housing, all dwelling buildings adopt a modular layout of building unit, which has separate controlled entrances, and consists of more than two dwelling units per floor surrounding one vertical transport core with elevators (Figure 5-4).

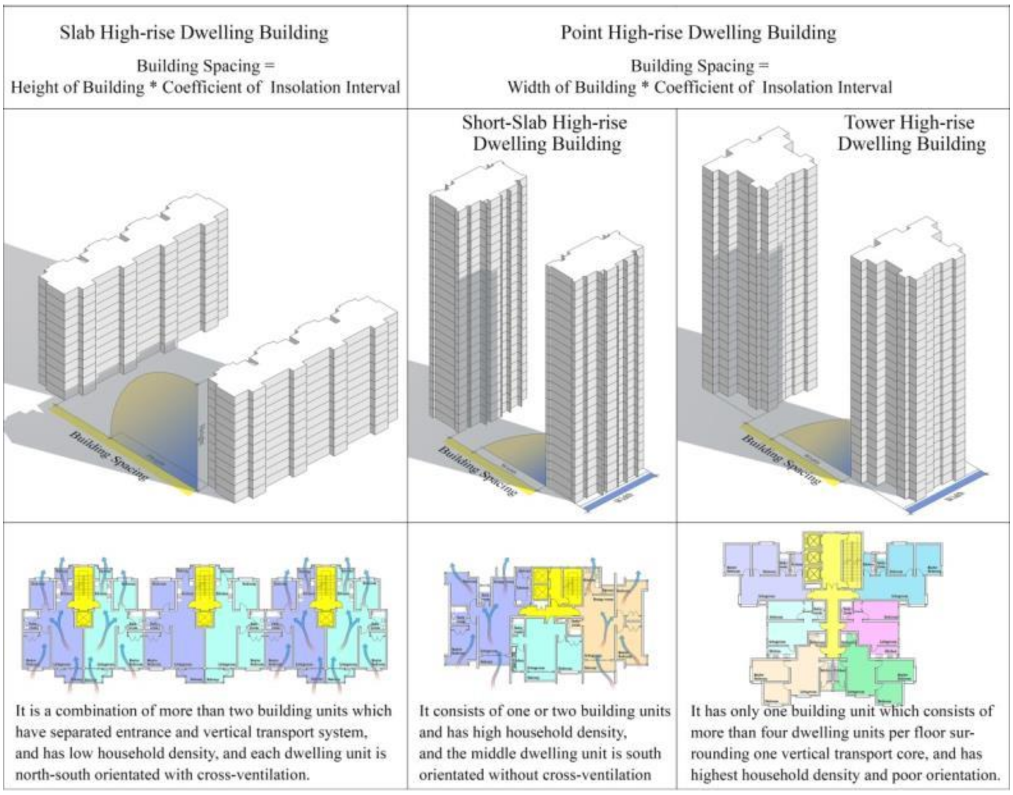


Figure 5- 4 Three Dominant Forms of High-rise Dwelling Buildings in Tianjin

All 4 cases contain short-slab high-rise housing. A typical short-slab high-rise dwelling building constitutes one or two building units (the vertical section of a dwelling building that has a separate entrance) that are comprised of 2 to 4 dwelling units per floor, with height ranging from 18 to 28 storeys (Figure 5-5). The slab high-rise dwelling buildings found in Cases 1 and 2, however, show different characteristics to the typical design. They contain more building units in one dwelling building (2-6 building units); consist less dwelling units on each floor (2-4 dwelling units per floor); and are lower in height (9-26 storeys). This has resulted in a relatively low household density within each building unit while maintaining high development intensity (as represented by the Plot Ratio). Case 4 has the highest household density of the 4 cases containing mostly tower high-rise dwelling buildings that are over 30 stores in height and consist of six dwelling units per floor.

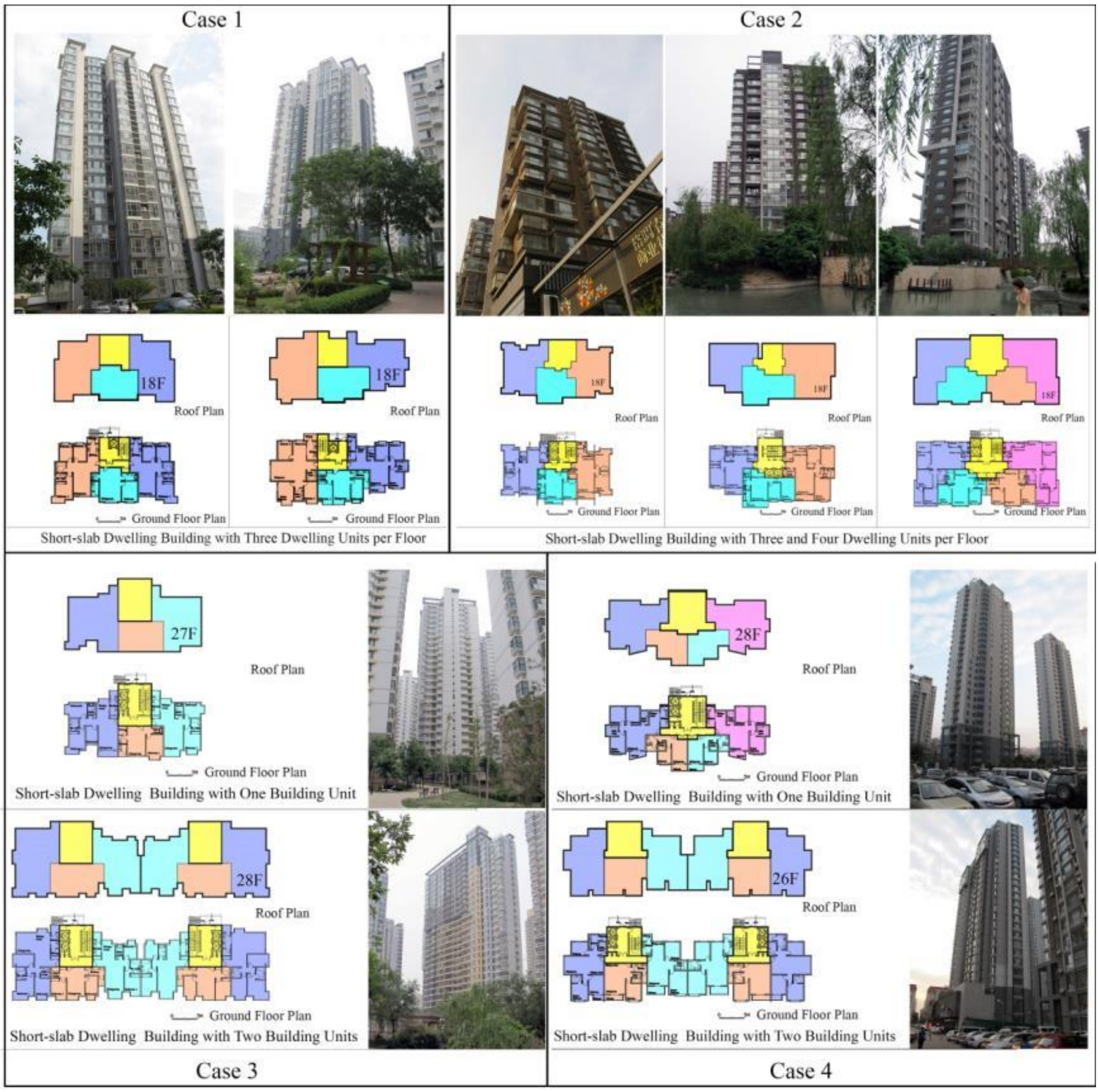


Figure 5- 5 Short-slab High-rise Dwelling Buildings in the Four Cases

The study cases have different architectural styles and façade designs, but lack diversity and identity within the communities. The design, decoration, management, and maintenance of communal spaces and facilities, such as entrances, lobbies, corridors, lifts and stairwells, vary from case to case. Overall, among the 4 cases, the façade design and inner management of Case 1 and Case 4 are relatively poorer, Case 2 has the most variety of dwelling buildings and façade designs, and Case 3 has the best communal spaces and facilities within dwelling buildings.

5.2.4 The Dwelling Units: different type distributions of dwelling units

At the spatial level of dwelling unit, four key features are studied in the selected cases, namely: size, ventilation and orientation, building form and property value. In terms of the size of dwelling units, two- bedroom dwelling units are the dominant type in the study cases, with the only exception of Case 2, where 3-bedroom flats achieved a slightly higher percentage (Table 5-2). 2- and 3-bedroom units combined together constitute over 80% in all 4 cases. The average size of dwelling units of the 4 cases are higher than the current average standard (74.3 M^2) of the inner city of Tianjin (SONBS 2011). The average size of Case 3 was the largest and that of Case 4 was the smallest due to high proportions of 1- and 2-bedroom dwelling units.

Table 5- 2 Type Distributions of Dwelling Units in 4 Study Cases

Size	Ventilation	Orientation	Building Form	Case 1 (%)		Case 2 (%)		Case 3 (%)		Case 4 (%)	
One-Bedroom	Without natural cross-ventilation	South	Short-slab high-rise	4	4	7	7	13	13	10	18
		West / East	Tower high-rise	N/V		N/V		N/V		8	
Two-Bedroom	With natural cross-ventilation	North-South	Slab high-rise	53	56	21	40	N/V	56	N/V	63
			Short-slab high-rise	N/V		N/V		30		32	
	Without natural cross-ventilation	South	Short-slab high-rise	3		19		26		15	
		West / East / South	Tower high-rise	N/V		N/V		N/V		16	
Three-Bedroom	With natural cross-ventilation	North-South	Slab high-rise	32	40	28	47	N/V	24	N/V	19
			Short-slab high-rise	8		19		24		19	
4-Bedroom	With natural cross-ventilation	North-South	Slab high-rise	N/V	N/V	6	6	N/V	7	N/V	N/V
			Short-slab high-rise	N/V		N/V		7`		N/V	

Source: compiled from the project archives of Tianjin Planning Bureau.

As shown in Table 5-2, the proportions of dwelling units with both cross-ventilation and north-south orientation are 93% in Case 1, 74% in Case 2, 61% in Case 3 and 51% in Case 4; the percentages of dwelling units that are located in slab high-rise housing are respectively 85% in Case 1and 55% in Case 2; the percentages of dwelling units that are located in short-slab high-rise housing are 15% in Case 1, 45% in Case 2, 100% in Case 3 and 76% in Case 4; the percentage of dwelling units located in tower high-rise housing is 24% in Case 4. This fact reflects the trend that more dwelling units have poor indoor environment quality with the increase of development intensity of high-rise housing estates.

In terms of property value, Case 1 and Case 2 have achieved a value increase of over 300% from 2005 to 2011, while Case 3 and Case 4 have achieved 200% value increase (Table 5-3). Among the 4 cases, the price of Case 2 is the highest, and that of Case 4 is the lowest. In terms of rental value, the rent of Case 2 and Case 3 are pretty close, and significantly higher than those of Case 1 and Case 4, which directly reflect the housing market's evaluation of the 4 estates.

Table 5-3 Comparison of Economic Data of Dwelling Unit in 4 Study Cases

Index			Case 1	Case 2	Case 3	Case 4	Average Level
1	Average Floor Area per Dwelling unit (M^2)		110	124	128	102	97.6
2	Original Average Price (RMB/M^2)		5040 (2004)	7320 (2005)	9100 (2007)	8500 (2007)	N/A
3	Average Price in 2011 (RMB/M^2)		17900	21100	20300	15300	17060
4	Average Rental in 2011 (RMB/Month)	One-Bedroom	1900	2600	2700	1800	1755
		Two-Bedroom	2500	3300	3500	2400	2230
		Three-Bedroom	3300	4400	5100	3200	4165
The exchange rate between the British Pound and the RMB is about 1/10. The annual per capita income in Tianjin was 26,921 RMB in 2011 (SONBS 2011).							

Source: compiled from the project archives of Tianjin Planning Bureau, the data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Center of Soufun.com Limited

5.3 Case 1 (ShengDa Garden): a high-rise housing estate dominated by slab high-rise dwelling buildings

Case 1 (ShengDa Garden) is a commercial housing development, which was developed from November 2003 to September 2005 by a medium-sized local private real estate developer (Figure 5-6). Among the 4 research cases, Case 1 was the first one to be developed and occupied. Before the development, the site of Case 1 was dominated by traditional courtyard houses with several industrial and commercial buildings along the streets. According to the Constructive Detailed Planning of Yuci-Road Site in Nankai District (TUPDI 2003), the majority of the old houses fell into disrepair, and the industries were closed down due to bankruptcy. All buildings in the identified site were demolished step by step, except for a nursery school and a primary school, which were planned for significant renovation. At the same time, the land to the south of the urban arterial road (Huanghe Road) was developed into office buildings, department stores and commercial housing estates. In 2007, the land to the north of Jin River began to be developed into high-rise housing estates dominated by short-slab and tower high-rise housing.

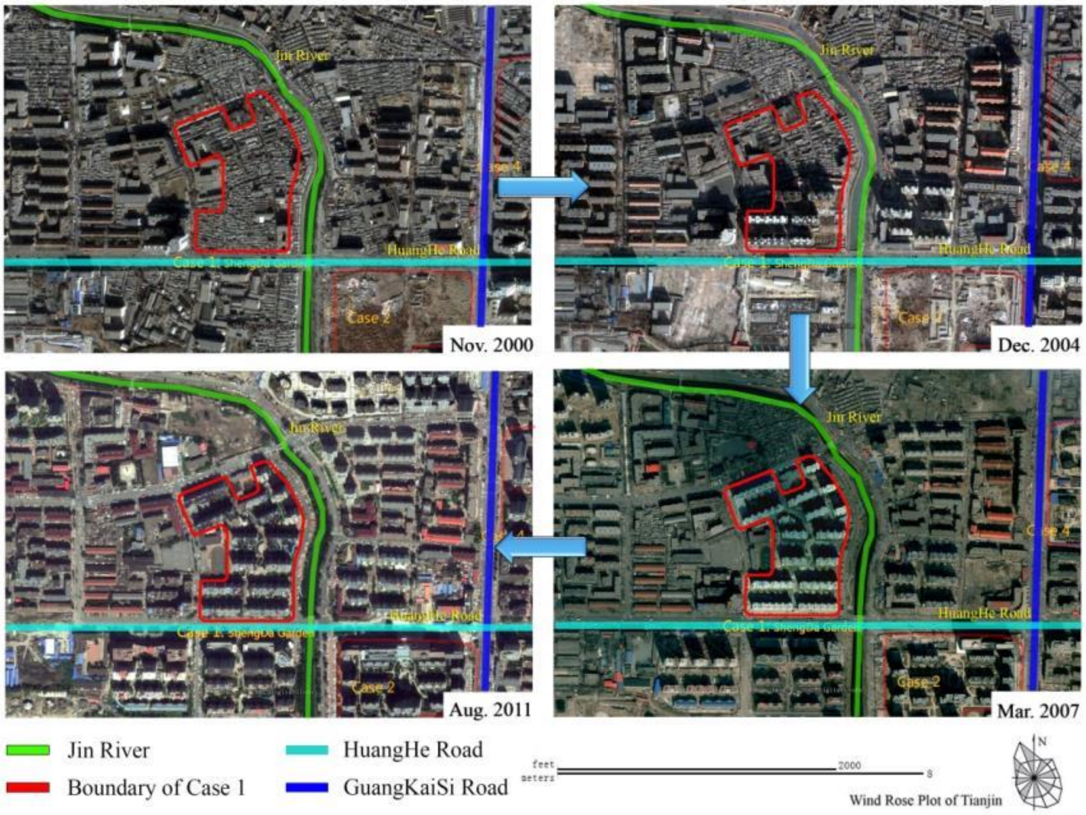


Figure 5- 6 The Construction of Case 1 within Tianjin's urban regeneration of the inner-city neighbourhood from 2000 to 2011
Top left: Before the beginning of urban renewal in 2003, the neighbourhood was composed of court-yard houses, multi-storey residential quarters, and industrial and commercial 'work units'. Top right: Case 1 under construction. The land to the south of HuangHe Road was being redeveloped into High-rise housing estates dominated by slab high-rises. Bottom right: Case 1 completed. The regeneration of the neighbourhood on the west of Jin River was nearing completion. Bottom left: the land on the north-west of Jin River was being developed into High-rise housing estates that were dominated by short-slab and tower high-rises.

5.3.1 A semi-mature urban neighbourhood

Case 1 is located in **a semi-mature urban neighbourhood** (Figure 5-7). The majority of the surrounding residential quarters have been occupied since 2008. ***Local public facilities***, such as schools, market and shops are distributed within a radius of 300 meters that is a comfortable walking distance (Kaźmierczak, Armitage et al. 2010). The riverside green space of Jin River provides an ***accessible and attractive public space***. ***The public transportation*** is very convenient. To the south of the estate, there is an urban arterial road -- HuangHe Road with a metro line and seven bus lines. Both the bus station and metro station that is being constructed are within walking distance to the southern entrance of Case 1. The adjacent neighbourhood also encompasses office buildings and a large department store.

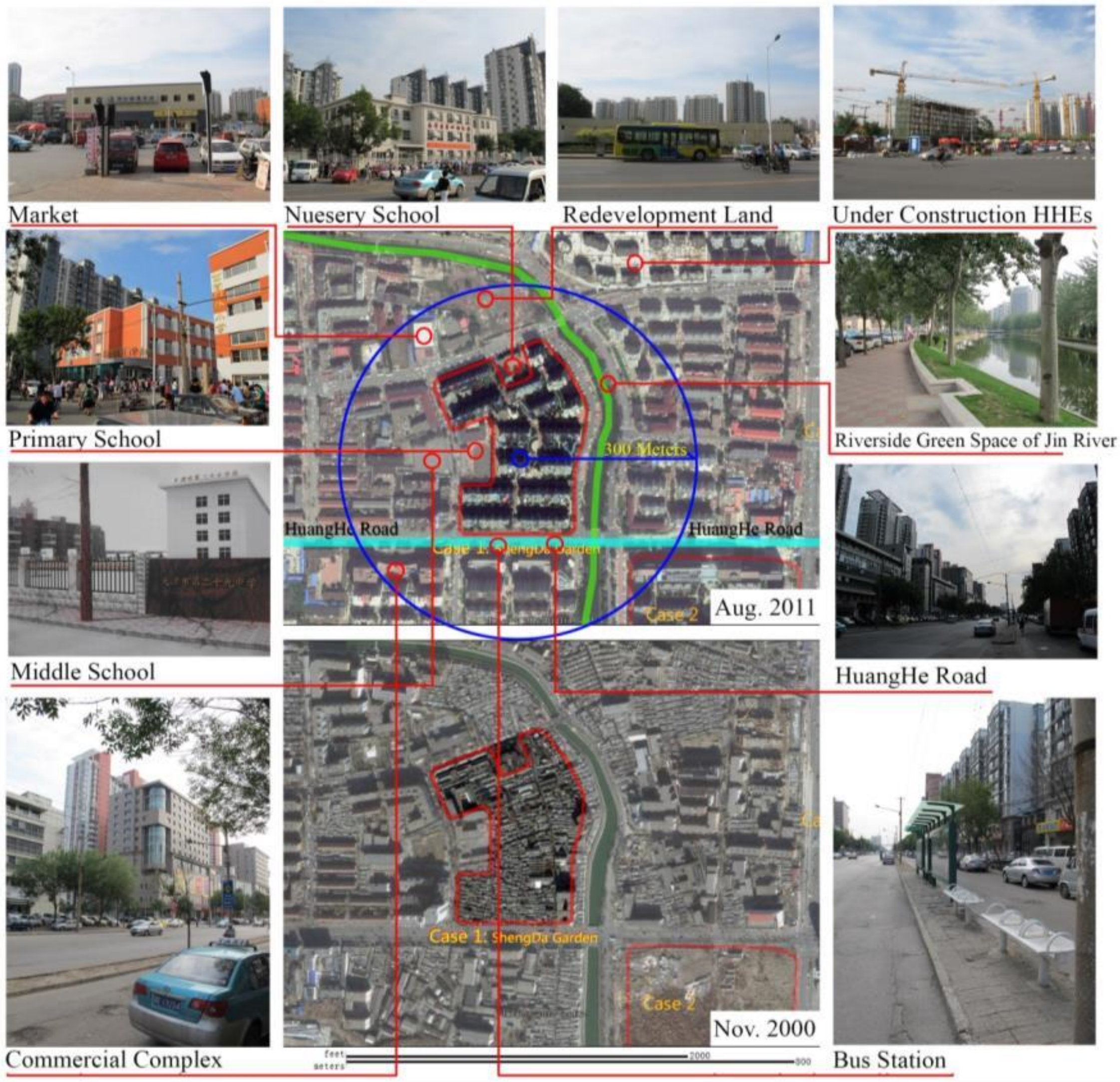


Figure 5- 7 General Conditions of the Surrounding Urban Neighbourhood of Case 1

Source: compiled from the map of Google Earth and photos taken by author

Negative environmental issues are also identified in the neighbourhood of case 1 (Figure 5-8). Firstly, ***the busy traffic*** has resulted in the ***congestion*** and the ***pollution of air and noise***. Especially the street on the west of case 1, where a primary school (1300 students) and a middle school (750 students) are located on either sides, is regularly congested during busy hours. Secondly, the informal open-air markets scattered in the neighbourhood have negative impacts on the ***environmental tidiness*** due to the lack of management and maintenance. Further, the demolished old buildings and the destroyed structures attracted some vagrants that put threats to ***public security***. Despite of these, many interviewees expressed strong ***neighbourhood attachment***, and were very satisfied with the location and macro urban environment.

Figure 5- 8 Environmental Issues of the Surrounding Urban Neighbourhood of Case 1

Top two: the chaotic and crowded streets on the west of the estate (Left: pedestrian and cyclists; Right: vehicles.); Middle two: the informal open-air market (Left: bicycle-repair shop; Right: pets and gardening market); Bottom two: the vandalized structure (Left) and demolished buildings (Right). Source: photos taken by author

Figure 5- 9 Problems of the Infrastructures in the Surrounding Neighbourhood of Case 1

Top left: the vandalized phone-box and mail-box. Top middle and right: the disrepair road drainage facilities and fire water supply facilities. Bottom three: the disordered communication cables in the air. Source: photos taken by author

Moreover, there are also problems with the urban infrastructures (Figure 5-9). The road drainage system lacks maintenance, which leads to frequent flooding of the streets. Because the utility tunnel system has not been constructed, the communication cables were disorderly hung in the air along the roads and streets, which not only deteriorated the urban landscape, but also brought potential safety problems. The public facilities, such as the phone-box and mail-box were vandalized and in a state of disrepair.

5.3.2 A housing estate with moderate development intensity and poor planning and community management

The Site of Case 1 (6.58 hectare) is enclosed by fences, walls and buildings, and has been managed and maintained by a local property management company. Compared with the other cases, the development intensity of Case 1 is at a low level, with household density: 194 households per hectare, plot ratio: 2.13, and building density: 18.5% (Table 5-4). A prominent issue is the low parking space per household (0.3 parking plot per household as regulated by TCMC 1995) that significantly lagged behind the development of car ownership in recent years.

Table 5- 4 Development Data of Case 1

Index		Unit	Nature
1	Time of Earth Breaking		Nov. 2003
2	Time of Delivering		Sep. 2005
3	Land Area of Housing Estate	Hectare	6.58
4	Residential Floor Area	M^2	140,350
5	Plot Ratio of Housing Estate		2.13
6	Average Building Height in Storeys	Storey	11.5
7	Insolation Interval		1.2H*
8	Net Residential Building Density	%	18.5
9	Green Area Ratio	%	35
10	Parking Space per Household		0.3
11	Number of Parking Spaces		427
12	Number of Households		1,276
13	Household Density	Household/Ha.	194
14	Property Service Charge	RMB/M^2.Month	1.2→1.5***
15	Residential Building Forms	12 slab high-rise housings (9 to 13 storey) 3 short-slab high-rise housings (18 storey)	

* H: Height of building = Height from the windowsill of ground floor to the cornice of building.
** W: Width of building = Projected width on the south
*** Service Charge just increased in 2011.
The exchange rate between the British Pound and the RMB is about 1/10.

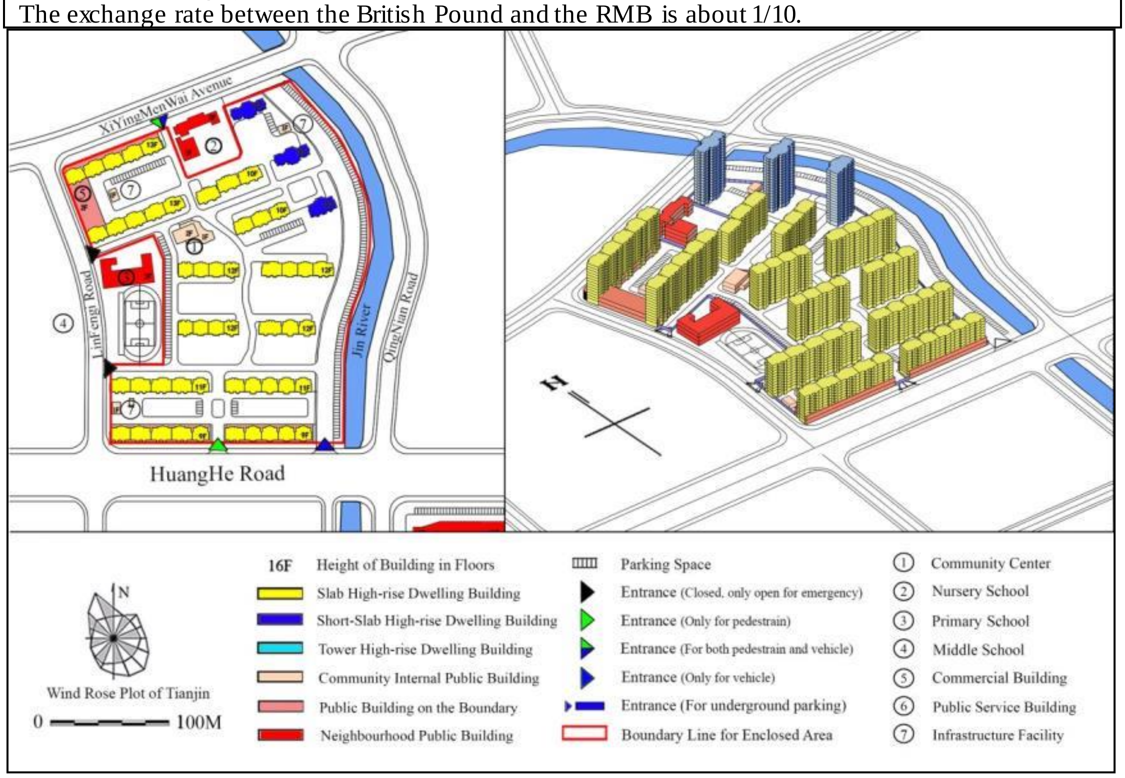


Figure 5- 10 Planning Layout of Case 1

Source: drawn by the author according to the project archive of Tianjin Planning Bureau

Case 1 consists of twelve slab high-rise housings (from 9-storey to 13-storey) and three 18-storey short-slab high-rise housings (Figure 5-10). The **planning layout** was the same to that of traditional multi-storey residential quarter where slab residential buildings were arranged in parallel rows in order to guarantee minimal cost and maximum amount of sunshine for all buildings.

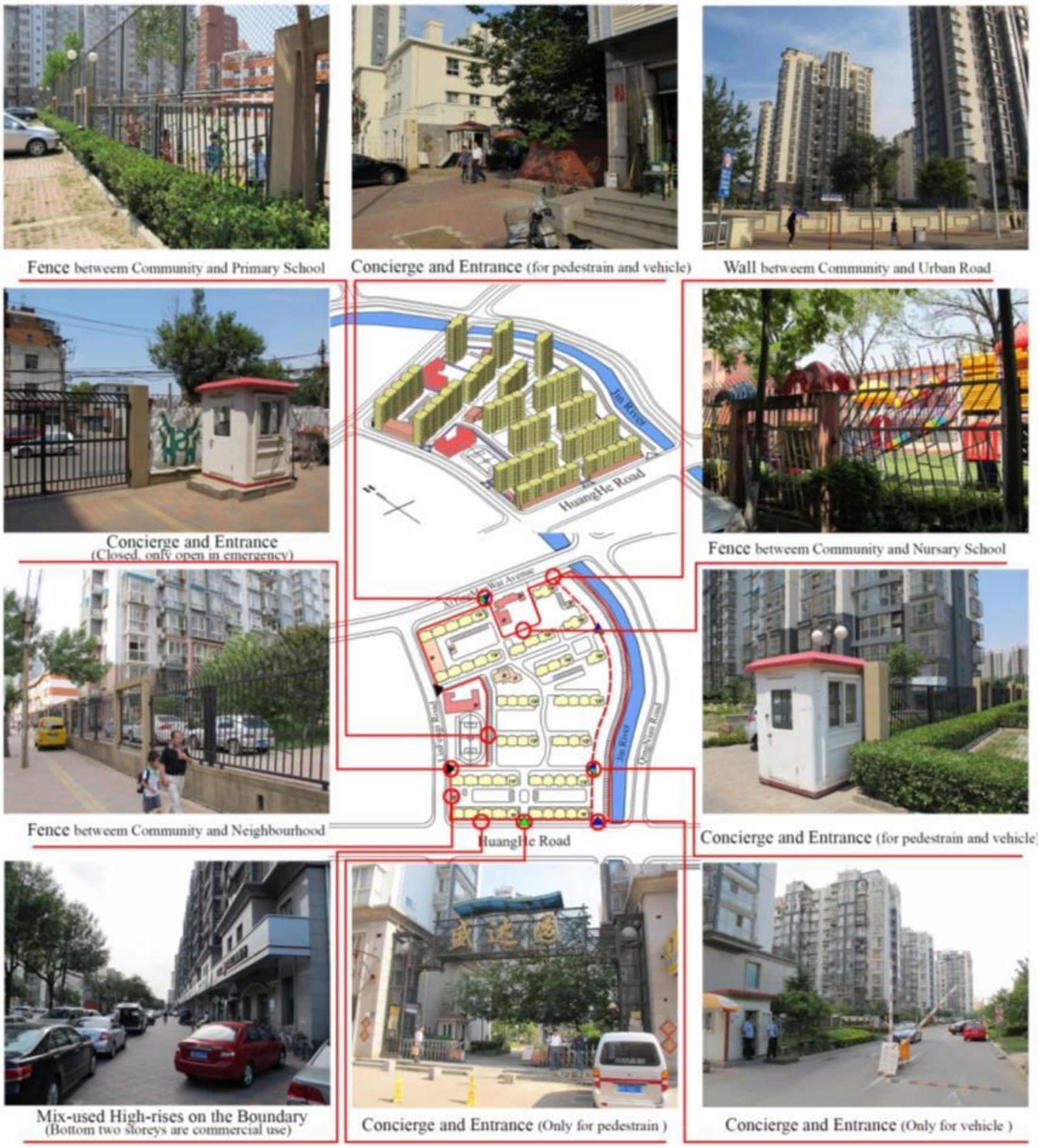


Figure 5- 11 the Boundary and Entrances of Case 1
Source: photos taken by author

The whole housing estate has five entrances, and its boundary is composed of metal fences, brick walls and mix-used buildings (Figure 5-11). Among the five entrances, two west entrances were usually closed to prevent the overload of LinFeng Road (on the west of the estate) and to save management costs. The north and south-east entrances are open to both pedestrian and vehicles, and the south entrance is only for pedestrians. The majority of the dwelling buildings located on the boundary of the estate is mix-used with the bottom two-storeys as shops facing urban streets. These shops include bank branches, retail shops, barber shops, property agents and restaurants serviceable to the whole neighbourhood.

Case 1 adopted **the pedestrian-vehicle-mixed internal traffic system** that permits vehicles enter into the community and access to every building, and pedestrians, cyclists and cars share the internal roads. The traffic system is propitious to cars, but impacts the safety of pedestrians and cyclists, and may cause the air and noise pollution within the community. According to the then prevailing planning code, only 1/3 (33.4%) of all households were entitled to a parking space, which led to the serious shortage of parking lots and increase of parking fee with the rapid increase of car ownership. In contrast, there are 1,535 bicycle parking lots, and the parking rate of bicycle is 120%. The planning of car and bicycle parking indicated the low car ownership rate of Tianjin in 2003. However, the past underestimate resulted in the current **insufficiency of parking spaces,** which is one of the prominent problems of Case 1. Many cars have to occupy the roads, walkways and green spaces, and the internal environmental quality of the community has been affected and is further deteriorating with the increase of private cars (Figure 5-12).

Figure 5- 12 the Conditions of Internal Traffic System of Case 1

Left top: off-street parking lots within the community; Left bottom: temporary on-street parking lots within the community; Middle top: internal street with car and bicycle parking lots; Middle bottom: pedestrians, cyclists and cars share the internal road; Right bottom: the centralized bicycle park with canopy; Right top: the distributed bicycle park near the entrance of each residential building. Source: photos taken by author

The green space and landscape of ShengDa Garden was planned to be **a distributed system,** which consists of nine small gardens and one central square. Two outdoor fitness and play facilities for the elderly and children are respectively located in the north and south part, and many small outdoor leisure facilities and municipal infrastructures are scattered in the gardens (Figure 5-13).

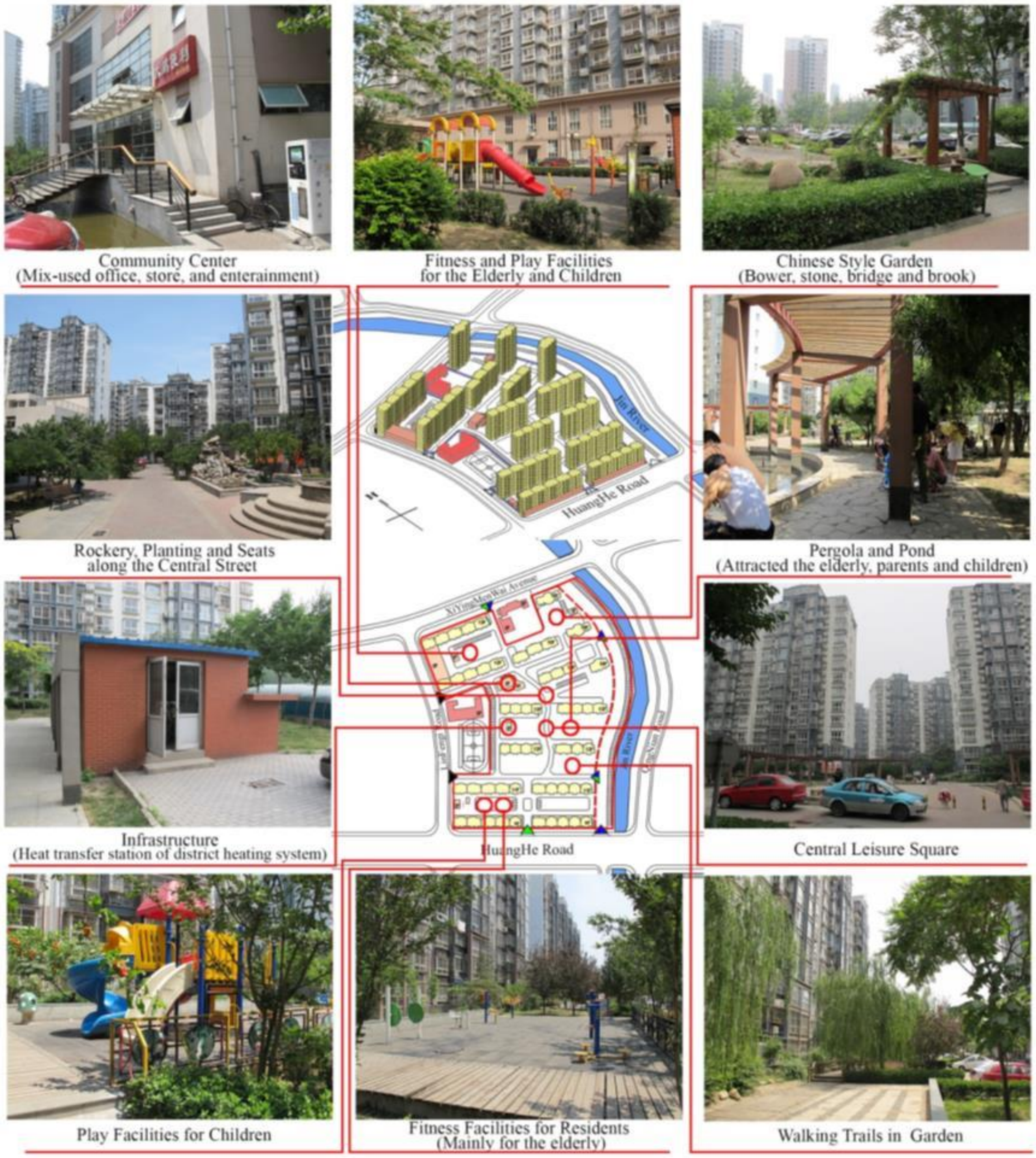


Figure 5- 13 Landscape and Public Facilities within the Community of case 1

Source: photos taken by author

Contradict to design intentions, play areas for children and the elderly lack attraction to residents due to the lack of shading facilities and tall trees in hot summer. This indicates that the planning and design of these spaces have not fully considered the practical use in Tianjin's weather conditions. More importantly, none of these designed spaces provided barrier-free facilities for the disabled and the elderly.

Although Case 1 had a designed green area ratio 5% higher than the national standard (30%), its green space was, in fact, largely turned into paved squares and parking lots by the estate management company for ease of maintenance and reduction in cost. According to an interview with the estate manager, two reasons had led to the act: Firstly, it has been difficult to collect property management fees sufficient for a maintained high environment quality. A vicious cycle has been created from the opposition of the residents' committee to increase on service charge to the subsequent decline of management quality and further resistance on service charge payments. Secondly, there is a serious shortage of parking spaces in the community. As a solution, some of the green spaces were transformed into parking lots upon consultation with the residents' committee.

Figure 5- 14 Security Management Problems of case 1

Left two: the irresponsible concierge; Right: the dense anti-theft windows of the lower-floor Dwelling Units. Source: photos taken by author

As observed by the author, the security management of the gated community is not sufficient. This can be speculated from the observation that the majority of lower-floor flats have anti-theft bars installed outside their windows (Figure 5-14). As reported by several interviewed residents, the concierge offices are often absent without notice, and CCTV have not been effectively fixed and used.

Public facilities also lack maintenance (Figure 5-15). Damaged public equipment have not been timely replaced and repaired, and the garbage has not been cleared up. Abuse on public facilities is also quite severe (Figure 5-16). For example, some ground floor residents occupied the communal green space nearby their dwelling units and constructed structures to prevent others from entering.

Figure 5- 15 Lack of Maintenance of Public Spaces and Facilities of case 1
Top left: the damaged street lamp; Top right: the broken apron and tiles; Bottom two: the piled garbage in the corners. Source: photos taken by author

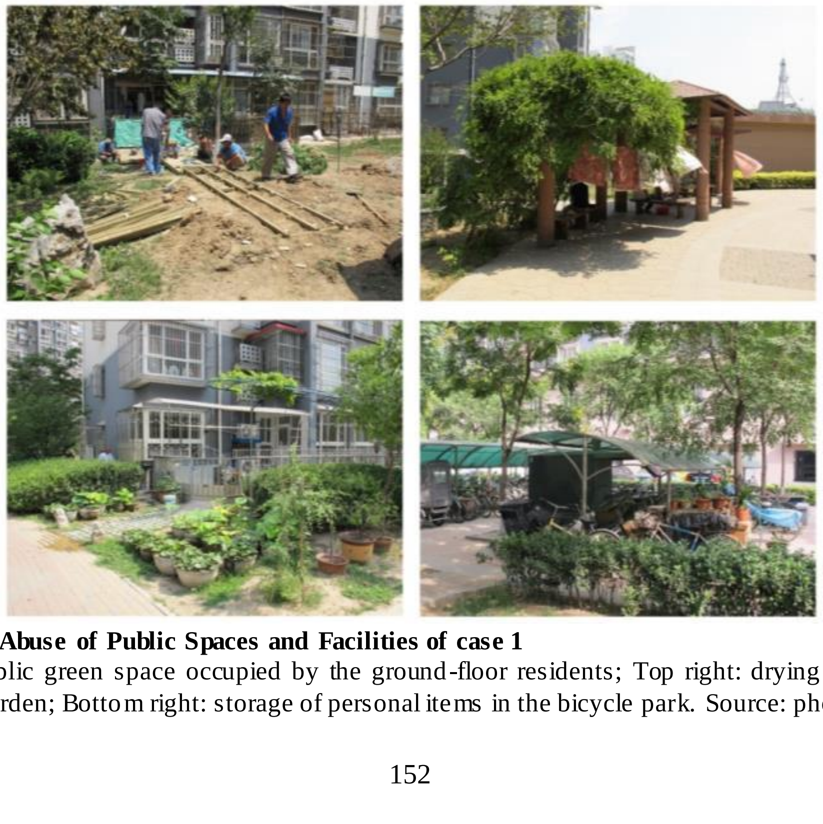


Figure 5- 16 Abuse of Public Spaces and Facilities of case 1
Left two: public green space occupied by the ground-floor residents; Top right: drying quilts in the communal garden; Bottom right: storage of personal items in the bicycle park. Source: photos taken by author

Residents living near the schools have reported noise from the primary school (Figure 5-17). No noise reduction measure has been taken in the primary school except for a 4-meter high metal fence that prevents the balls to be kicked over. Comparatively, dense and lush trees have been planted to weaken the impact of noise from the nursery school. The monotonous architecture forms and façade designs lack identity and accessibility of public facilities and spaces for the disabled and the elderly are poor due to the lack of disabled ramp and auxiliary equipment.

Figure 5- 17 Impact of the Two Schools on the Community of case 1

Left: the isolation strip between the primary school and the community cannot effectively reduce the noise; Right: the isolation strip between the nursery school and the community has a better effect of noise reduction. Source: photos taken by author.

5.3.3 The majority slab high-rise dwelling buildings

In terms of building form, Case 1 encompasses two types of high-rise building: slab high-rise and short-slab high-rise. The former are between 9- to 13-storeys with 3 to 5 building units (Figure 5-18); the latter are 18-storeys with only one building unit each (Figure 5-19). Each building unit has its own vertical transport system and separated entrance with the building intercom system operating 24/7. As a form of collective residential environment, the combination of slab- and short-slab high-rise buildings provides a variety of household clusters of between18 (2 dwelling units per floor over 9 storeys) to 54 households (3 dwelling units per floor over 18 storeys) per building. All of the buildings have a similar façade design, same materials and colour assortments, which form the holistic architectural style of the community along with the humdrum internal environment and poor identify of individual buildings.

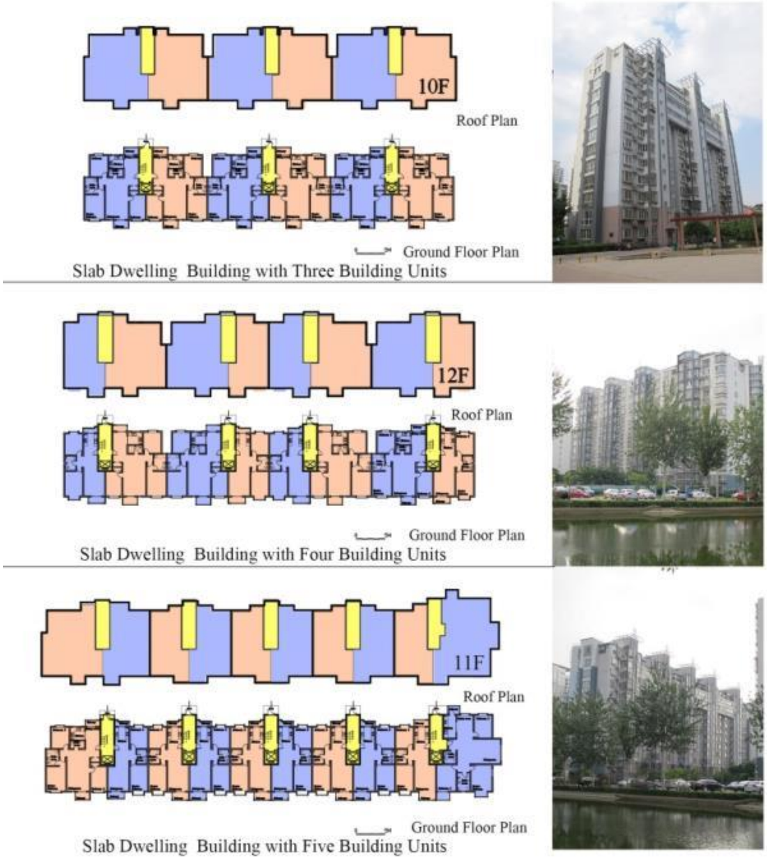


Figure 5- 18 Three Types of Slab High-rise Dwelling Building in Case 1

Figure 5- 19 Two Types of Short-slab High-rise Dwelling Building in Case 1

Moreover, the dwelling buildings of case 1 can be divided into two types: single-use residential building and mixed-use residential building. The majority of the single-use dwelling buildings are located in the middle of the community, and the mixed-use high-rise housings are located on the boundary of the community (Figure 5-20). For the mixed-use housings, the bottom two-storey are dedicated to commercial use and are open to the surrounding neighbourhood, and the upper residential parts have separated entrances with security monitoring within the gated community.

Figure 5- 20 Single-use and Mixed-use High-rise Housings and Their Context

However, the actual usage situations of the commercial parts are inconsistent with the original design and planning (Figure 5-21). On the one hand, some of the ground-floor shops on the boundary of the community were transformed to be facing the community in order to serve the internal residents more conveniently. This has resulted in unmonitored entrances into the gated community, which has weakened the security management on the whole. On the other hand, some of the ground-floor dwelling units were turned into commercial uses, such as beauty shop and fitness centres, which indicated the insufficiency of the original internal service facilities. Similarly, the functional change brought about negative influence on the security control of the entrances of the building units. Moreover, many residents spontaneously installed the anti-theft windows and changed the air conditioner outdoor units, which further damaged the façade of dwelling buildings.

Figure 5- 21 Residents' Spontaneous Transformations of Dwelling Buildings in Case 1

Left Two: the modified entrance of bottom-two-storey shop on the boundary of community; Middle Two: the ground-floor dwelling units that were changed to beauty shop and fitness centre; Right Two: the private yard, the various anti-theft windows and the chaotic air conditioner outdoor units. Source: photos taken by author

Another prominent issue that impacts the dwelling buildings is parking and anti-theft of bicycles. Apart from the centralized bicycle parking lots, dispersive bicycle racks were also allocated near the entrances of each dwelling building. However, the quantity and safety provided by these planned facilities are still insufficient, as many residents preferred parking their bikes in the communal lobbies and corridors of dwelling buildings to prevent theft (Figure 5-22).

Figure 5- 22 Problems of Bike Anti-theft and Parking in Case 1

Figure 5- 23 Communal Spaces and Facilities within Dwelling Buildings of case 1

Top Left: the entrance of dwelling building with building intercom system and unclear address identification; Top Middle: the lift lobby, hydrant and heating tube with adhesive small ads; Top Right: the posters and electric meter boxes on the wall of corridor; Bottom Left: the lobby combined with stair well, and the bulletin board on the wall; Bottom Middle: the window and infrastructure in stair well; Bottom Right: the unlocked equipment box. Source: photos taken by author

The communal spaces and facilities within dwelling buildings were maintained better than those in the estate in spite of some graffiti (usually as informal advertisement posters) (Figure 5-23). The stair wells have windows that can provide natural lighting and ventilation, but elevator halls and corridors rely on artificial lighting. It is worth noting that no ramp was provided to access lifts, which influences the accessibility for the elderly and the disabled.

5.3.4 The luxury dwelling units with basic design

In China, per capita residential floor area is an important indicator of the quality of living. In Case 1, this figure is 34.4 square meters per capita - a level much higher than the average level of the inner city of Tianjin at the time of its planning (23.1 square meters per capita). In terms of property value, Shengda Garden has achieved a much higher value increase since its completion than the city average in the same period and its property prices are among the highest in the inner city of Tianjin (Table 5-5).

Table 5- 5 Economical Index of Dwelling Unit of Case 1

Index			Case 1 (ShengDa Garden)	The City Average
1	Average Floor Area per Dwelling unit (M^2)		110	97.6
2	Original Average Price (RMB/M^2)		5,040 (2004)	4115 (2004)
3	Average Price in 2011 (RMB/M^2)		17,900	17,060
4	Average Rental in 2011 (RMB/Month)	One-Bedroom	1,900	1,755
		Two-Bedroom	2,500	2,230
		Three-Bedroom	3,300	4,165
The exchange rate between the British Pound and the RMB is about 1/10. The annual per capita income in Tianjin was 26,921 RMB in 2011.				

Source: compiled from the project archives of Tianjin Planning Bureau, the data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Center of Soufun.com Limited

Table 5-6 Type Distribution of Dwelling Units of Case 1

Case 1: ShengDa Garden – Dominated by slab high-rise housings								
Size	Orientation	Ventilation	Building Form	Typology of layout	Range of net floor area	Amount	Proportion (%)	
One-Bedroom	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	1	65	54	4	4
Two-Bedroom	North-South	Good natural cross-ventilation	Slab high-rise	6	75-90	676	53	56
	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	1	80	36	3	
Three-Bedroom	North-South	Good natural cross-ventilation	Slab high-rise	5	95-120	402	32	40
			Short-slab high-rise	2	100-125	108	8	

Source: compiled from Constructive Detailed Planning of YuCi-Road Site in NanKan District (TUPDI 2003)

There are 5 different types of dwelling units according to the size, orientation, ventilation and building form (Table 5-6). All of one-bedroom flats are south-oriented without cross-ventilation. Two-bedroom flats incorporate two types: north-south orientation with cross-ventilation and south orientation without cross-ventilation. All of three-bedroom flats have north-south orientation and cross-ventilation. In fact, as a rule of thumb in the housing market, larger properties usually enjoy better indoor thermal comfort.

Figure 5- 24 Typical Layout Plans of Dwelling Units of Case 1

In terms of the layout of dwelling units, the main features can be summarized from three aspects: family living space, individual rest space and service space (Figure 5-24). For living space, a separated dining-room and a south-facing living-room are the key features property buyers usually desire. As for rest space, the number and orientation of bedrooms, as well as natural day-lighting and ventilation of bathrooms and en-suites are important characteristics. **The lack of storage spaces** has been identified as a common problem in the various types of dwelling units.

In the climatic condition of Tianjin, where sand storms are a regular occurrence, the cleaning of the external windows on high-rise buildings is both labour- and cost-intensive. Consequently, few property management companies could provide the service as it is demanded, causing wide-spread complaints. For the same reason, the balconies, usually an important outdoor living space for high-rise housing, could seldom survive the destiny of being enclosed by fixed windows, as the strong winds in spring would turn them into dust trays. In fact, the majority of the balconies on high-rise dwelling buildings in Tianjin are transformed into conservatory, storage, laundry, and even kitchen (Figure 5-25).

Figure 5- 25 Problems of Dwelling Units in Case 1
Left two: the views from windows; Middle two: the balconies enclosed by windows that were installed by residents themselves; Right two: the platforms for air condition outdoor units have been transformed into mini-balcony and storage. Source: photos taken by the author.

5.4 Case 2 (Style of Spring): a high-rise housing estate with mixed slab and short-slab high-rise dwelling buildings

Case 2 (Style of Spring) is the final phase of a series of commercial housing developments which were developed from May 2003 to April 2007 by a large local developer with a reputation for high quality housing development (Figure 5-26). In 2008, it won the China Civil Engineering ZhanTianYou Award, which was one of the most influential national prizes in China's building industry.

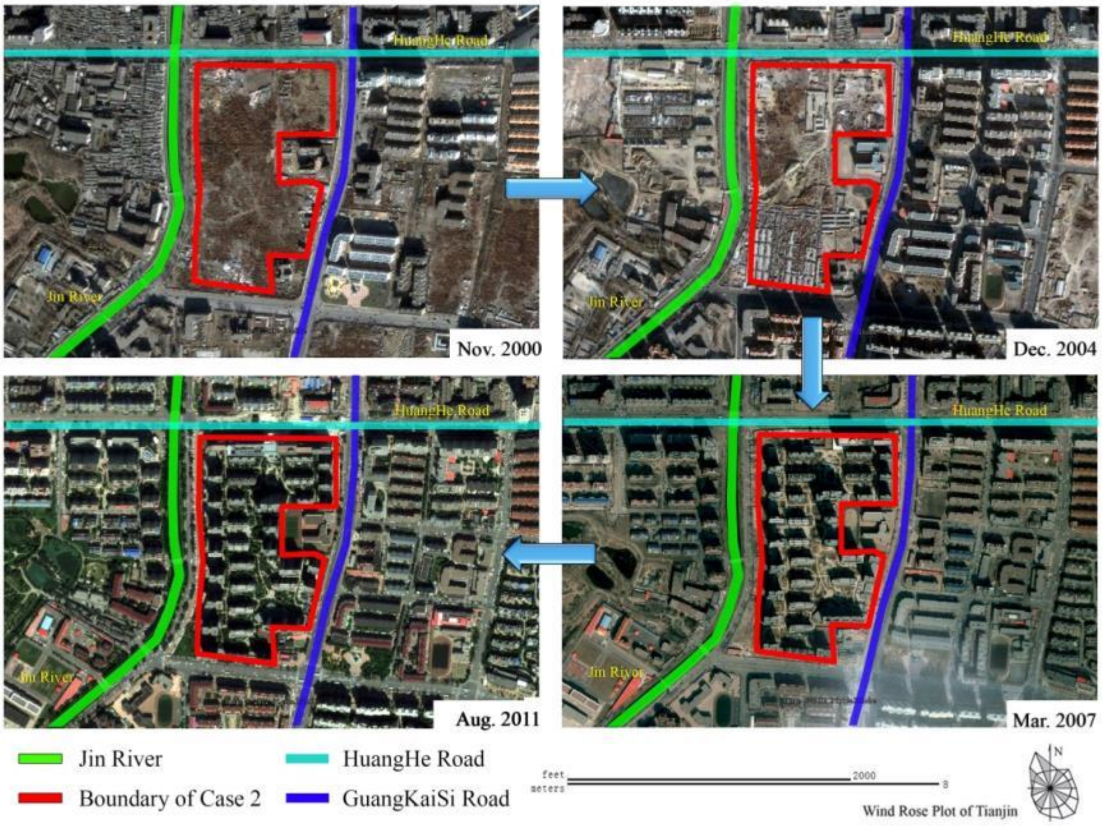


Figure 5- 26 The Construction of Case 2 in the process of inner-city urban regeneration in Tianjin

Top left: Before 2000, the urban neighbourhood of Case 2 had begun to be redeveloped, and the multi-storey residential quarters were under construction. The old buildings on the site of Case 2 have been demolished. Top right: The surrounding urban blocks of Case 2 were developed into housing estates that dominated by the slab multi-storey and high-rise housings. Bottom right: Case 2 and the regeneration of the surrounding neighbourhood have just been completed in 2007. Bottom left: the urban park on the west of Jin River was renovated.

5.4.1 A mature urban neighbourhood

The neighbourhood renewal of case 2 was fully completed in 2007. At the present, the neighbourhood of case 2 is relatively mature than those of the other cases. Within a radius of 300 meters, ***attractive public spaces*** including riverside greenbelt, urban gardens and squares scattered around the community (Figure 5-27). The ***availability and accessibility of local service facilities,*** such as bank, hospital and school, are at high levels. The local primary school has a very high reputation, which is an important selling point of case 2 on the housing market. Except the west road, the other three urban roads surrounding the community are busy and noisy, while ***the public transport*** system consisting of bus and metro is very convenient. Benefited from the central location and convenient facilities, the majority of interviewees had strong ***neighbourhood attachment.***

Figure 5- 27 General Conditions of the Surrounding Urban Neighbourhood of Case 2

Source: compiled from the map of Google Earth and photos taken by author

Some problems in the urban neighbourhood are also identified (Figure 5-28). Besides the traffic ***noise***, ***the maintenance of infrastructure facilities*** and ***public spaces*** is another negative issue that impacts residents' daily lives. For example, the broken ground tiles of walkways, which are often occupied by bikes and motors, lack repair. Extensive litter can be seen in many public spaces, which resulted in ***poor environmental tidiness***. The ***public security conditions*** were complained by many interviewees due to the theft of bikes and motorbikes.

Figure 5- 28 Environmental Issues of the Surrounding Urban Neighbourhood of Case 2

Left two: the infrastructure facilities lack maintenance; Middle three: the walkway was occupied by motorbikes, and the broken ground tiles and railings have not been repaired and replaced; Right two: rubbish in public spaces have not been collected and cleaned. Source: photos taken by the author.

5.4.2 A housing estate with low development intensity and good planning and community management

Case 2 is the largest in area among all cases, with a land area of 9.65 hectares housing 1775 households. Its plot ratio is 2.29, which means **higher development intensity** than Case 1. The household density is slightly lower than Case 1 due to larger floor area per household. The property service charge increased in 2011, but was still at a moderate level (YJDC 2011). Similar to Case 1, low parking space per household (0.8) is the main problem impacting the residents' daily lives. As is the case with Case 1, the inadequate provision as regulated by current planning codes bears responsibility.

Table 5-7 Development Data of Case 2

Index		Unit	Nature
1	Time of Earth Breaking		Mar. 2005
2	Time of Delivering		Apr. 2007
3	Land Area of Housing Estate	Hectare	9.65
4	Residential Floor Area	M^2	220,900
5	Plot Ratio of Housing Estate		2.29
6	Average Building Height in Storeys	Storey	12.4
7	Insolation Interval		1.2W**/1.3H*
8	Net Residential Building Density	%	18.5
9	Green Area Ratio	%	43
10	Parking Space per Household		0.8
11	Number of Parking Spaces		1,360
12	Number of Households		1,775
13	Household Density	Household/Ha.	184
14	Property Service Charge	RMB/M^2.Month	1.5→1.8***
15	Residential Building Forms	16 slab high-rises(9 to 24 storey) 17 short-slab high-rises (18 to 26 storey)	

* H: Height of building = Height from the windowsill of ground floor to the cornice of building.
** W: Width of building = Projected width on the south
*** Service Charge just increased in 2011.
The exchange rate between the British Pound and the RMB is about 1/10.

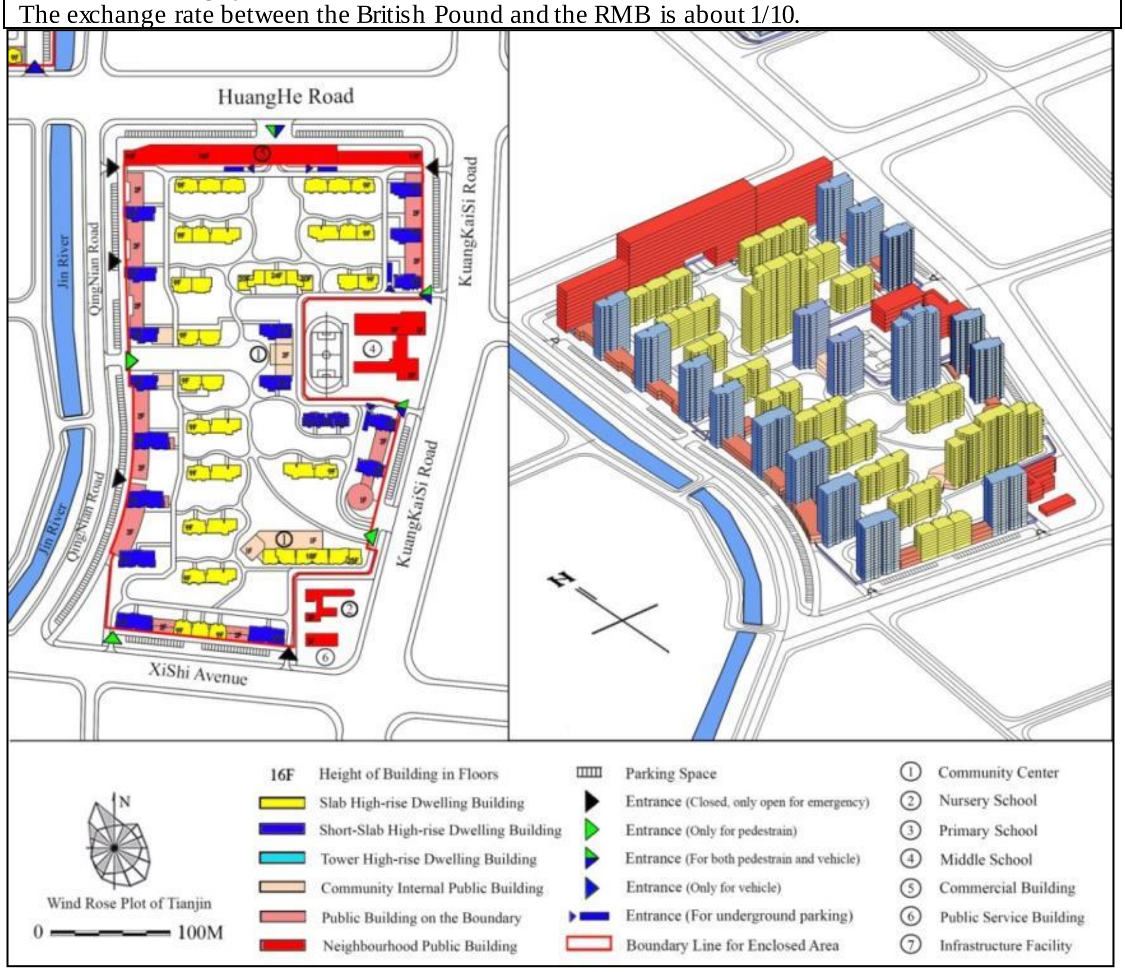


Figure 5-29 Planning Layout of Case 2
Source: drawn by the author according to the project archive of Tianjin Planning Bureau

Case 2 is comprised of 16 slab high-rise dwelling buildings and 17 short-slab high-rise dwelling buildings, which are all north-south orientated (Figure 5-29). The majority of slab high-rises are located in the centre of the community, with all of short-slab high-rises arranged near the boundaries. An office building was built on the north of the housing estate, next to an urban arterial road (HuangHe Road). The mixed residential and commercial development has brought more profit for the developer, but also the two-storey commercial buildings on the boundary of the housing estate effectively reduced the impact of external urban traffic noise on the community. The combination of various building forms constituted **a rich and varied outdoor environment**, which is the most significant feature distinguishing from the other three study cases.

Figure 5- 30 Boundary and Entrances of Case 2

Between the estate and the schools, tall trees were planted along the walls and steel fences in order to reduce the noise. Bicycle parking lots with canopy were built against the wall, which played a similar role of noise reduction. A total of 11 entrances were planned with only 5 in use (Figure 5-30). All of the entrances are strictly monitored with concierge and CCTV. The main entrance on the east leads to the community centre and central garden, and the west entrance leads to an internal shopping street that serves exclusively community residents.

Figure 5- 31 Internal Traffic System of Case 2
Left three: the external parking lots and the internal underground park nearby the main entrances; Middle three: the pedestrian trails with porous pavement. Right three: the barrier-free traffic roads with bicycle parking lots. Source: photos taken by the author

Case 2 adopted **the pedestrian-vehicle-separated internal traffic system** (Figure 5-31). According to the then prevailing planning code, 80% of all households were entitled to a parking space, which led to the serious shortage of parking lots and increase of parking fee with the rapid increase of car ownership. The internal roads are dedicated to bicycle and pedestrian uses and would only allow vehicle entrance in times of emergency or for service vehicles allowed by the property management company. These roads can be divided into traffic roads and pedestrian trails. Along the traffic roads there are bicycle lots with canopy. The pedestrian trails meander through the communal gardens. All of these roads adopted barrier-free design and porous pavement, which not only satisfy the specific needs of the elderly and disabled, but also improved the traffic safety in times of rain and snow.

Figure 5-32 Landscapes and Public Facilities of Case 2

Case 2 has a **high green area ratio** of 43% that is significantly higher than the planning regulation of 30% (CAUPD 2002). Besides small gardens dispersed between the buildings, there are also two central gardens located in the middle of the community (Figure 5-32). Both of the two central gardens are designed as modern-style Chinese gardens with small lakes, stones, pavilions and bridges, which provide attractive leisure spaces within the community along with high maintenance costs. Another feature of the landscape design is the arbours and bushes planted around the high-rise dwelling buildings. This design has served to weaken the huge volume of high-rise buildings, as well as provide good aesthetics at pedestrian level. Moreover, the community also provides a **variety of public facilities**. Unlike the other cases, an internal shopping street was planned nearby the west entrance. However, the site survey found that the internal shops are struggling to make a good profit due to the limited number of customers within the community, while the external shops serving the urban neighbourhood were at much better situation. The community centre, property service centre, fitness centre and community clinic are distributed in the housing estate. An outdoor fitness place for the elderly is located in the front of the community clinic, and attracts many elderly people.

The only playground for children becomes the most attractive place where many elderly people (grandparents) and young parents supervise their children, and at the same time lots of positive interactions among the residents occur. Another smart design is a combination of the open-air tennis court on the roof of the semi-underground bicycle park. Benefiting from the large building spacing between high-rise housings, there are a great number of space and land to be used as landscape and public facilities that can effectively improve the quality of both physical and psycho-social environment.

However, there do exist some problems at the spatial level of housing estate in Case 2. Firstly, facilities for children and the elderly are inadequate given the demands by the large community population. Moreover, the large spatial scale of the estate makes it inconvenient for children and the elderly to go outside on a daily basis and enjoy facilities provided by the outer neighbourhood. Secondly, the management and maintenance of housing estate have some shortcomings. According to some interviewees, bike-theft is a key issue on estate security management. In addition, the ineffective maintenance of landscape resulted in the degradation of grassland and disrepair of some public facilities (Figure 5-33).

Figure 5- 33 Problems of Management and Maintenance of Case2

Top three: soil exposed due to grass degradation. In windy weathers, dust pollution severely affected the outdoor and indoor environment; Bottom three: broken ground tiles, crooked lamppost and cracking landscape wall.

5.4.3 The mixed slab and short-slab high-rise dwelling buildings

Case 2 is comprised of two types of **building forms**: slab and short-slab high-rise dwelling building. The former include fourteen 9-storey, one 18-storey and one 24-storey dwelling buildings. The slab high-rise buildings are combined by two or three building units with separate entrances and vertical traffic systems (Figure 5-34). Short-slab housing consists of seventeen 18-storey dwelling buildings (Figure 5-35), and the majority of which were integrated with low-rise commercial buildings on the boundaries of the gated community. The **household density** of the slab housing ranged from 18 (2 dwelling units per floor over 9 storeys) to 54 households (3 dwelling units per floor over 18 storeys). **The household density** of the short-slab housing ranged from 54 (3 dwelling units per floor and 18 storeys) to 72 households (4 dwelling units per floor and 18 storeys).

Figure 5- 34 Three Typologies of Slab High-rise Dwelling Building in Case 2

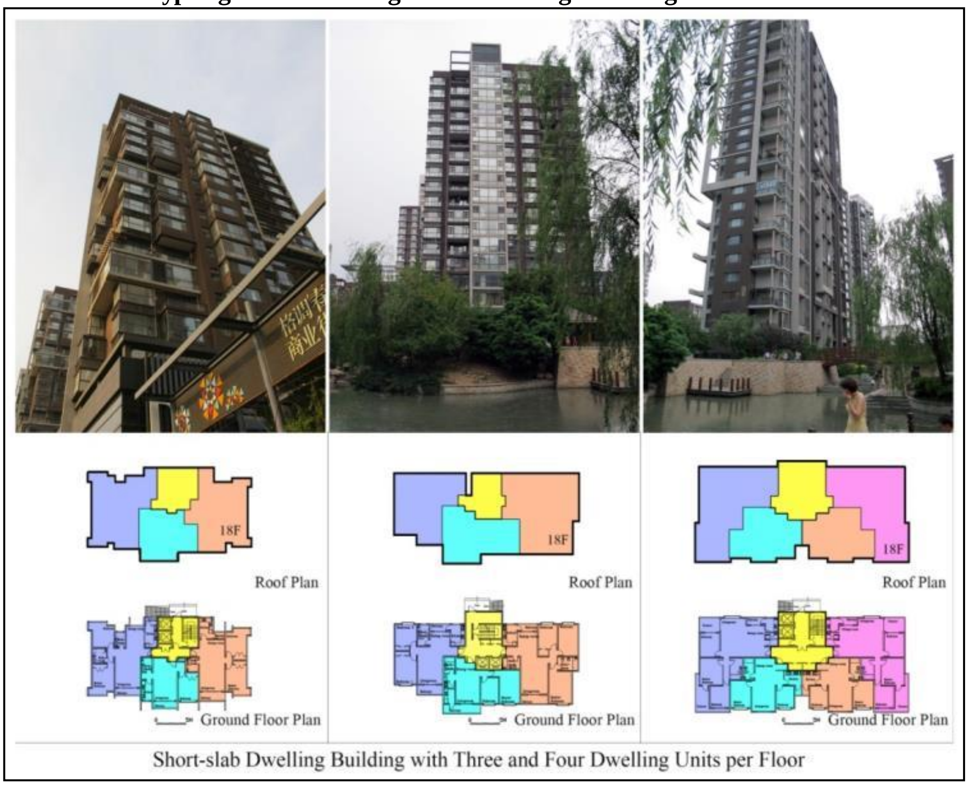


Figure 5- 35 Three Typologies of Short-Slab High-rise Dwelling Building in Case 2

Despite of some variety on the design of building facades, **the identity of buildings** are still poor, which have been identified in the interviews and field investigations. All building entrances adopted **barrier-free design** for the elderly and disabled. The mailboxes and garbage bins are placed nearby the entrances, but separate waste collection has not been adopted. Moreover, **the construction quality** of dwelling buildings are quite low (Figure 5-36). Given the fact that this development is the winner of the most prominent award in China's building industry, it is an indication of the general low level of construction quality of the housing industry in China.

Figure 5- 36 Problems of Construction Quality of Dwelling Buildings in Case 2

Left two: the broken facilities and doors; Middle two: the cracking wall coating and the shedding wall tiles; Right two: the loosen rainwater pipe and the rusted railings. Source: photos taken by the author

In terms of **management and maintenance**, there are some problems to influence the residential environment. Anti-theft windows are installed on the majority of ground-floor flats (Figure 5-37). In addition, certain public facilities both inside and outside of dwelling buildings such as mailboxes and lifts were doodled and scratched, and are in a state of disrepair. In order to prevent theft, some residents parked their bikes in the communal corridors. Another common phenomenon is the abuse of communal spaces within dwelling buildings. Many residents store their private items in elevator halls and staircases. Through the site survey, it was discovered that the main problem was the poor quality of management and maintenance, rather than the lack of security facilities.

Figure 5- 37 Problems of Management and Maintenance of Dwelling Buildings in Case 2

Left two: the communal spaces were used to store the private items; Middle two: the anti-theft windows and locked bikes in lift lobby; Right two: the nicks and graffiti on the lift and mailboxes. Source: photos taken by the author.

5.4.4 The luxury dwelling units with diversified designs

According to the statistical data of Soufun.com (2012), the average property price in Case 2 was much higher than the average level of similar property developments in Tianjin (Table 5-8). The size of the average dwelling unit in Case 2 was also significantly larger than that stipulated in TUPDI (2011).

Table 5- 8 Economics Index of Dwelling Unit of Case 2

Index			Case 2 (Style of Spring)	Average Level
1	Average Floor Area per Dwelling unit (M^2)		124	97.6
2	Original Average Price (RMB/M^2)		7320 (2005)	5004 (2005)
3	Average Price in 2011 (RMB/M^2)		21100	17060
4	Average Rental in 2011 (RMB/Month)	One-Bedroom	2600	1755
		Two-Bedroom	3300	2230
		Three-Bedroom	4400	4165
The annual per capita income in Tianjin was 26,921 RMB in 2011. The exchange rate between the British Pound and the RMB is about 1/10.				

Source: compiled from the project archives of Tianjin Planning Bureau, the data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Centre of Soufun.com Limited

Case 2 has the greatest variety of dwelling unit types among all 4 study cases. There are six different types of dwelling units with varied size, orientation, ventilation and building form (Table 5-9). The proportion of large dwelling units (3-4 bedroom units) is 53%. All of the small flats with one and two bedrooms were oriented to the south to maximize natural lighting.

Table 5-9 Type Distribution of Dwelling Units of Case 2

Case 2: Style of Spring -- Mixed slab and short-slab high-rise housing estate								
Size	**Orientation**	**Ventilation**	**Building Form**	**Typology of layout**	**Range of floor area**	**Amount**	**Proportion**	
One-Bedroom	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	4	60-70	122	7%	7%
Two-Bedroom	North-South	Good natural cross-ventilation	Slab high-rise	5	75-110	366	21%	40%
	All windows facing South	Poor natural cross-ventilated	Short-slab high-rise	2	80-110	336	19%	
Three-Bedroom	North-South	Good natural cross-ventilation	Slab high-rise	5	105-135	502	28%	47%
			Short-slab high-rise	6	95-125	336	19%	
4-Bedroom	North-South	Good natural cross-ventilation	Slab high-rise	5	135-160	113	6%	6%

The majority of dwelling units have separate dining-rooms and en-suite main-bedrooms (Figure 5-38). Compared with the other cases, the dwelling units of case 2 provided more storage spaces and larger balconies, and extra outdoor space in the form of roof-top terraces. Some of interviewees complained about the large French windows facing the west due to the western exposure in hot summer despite of good views. As many studies have indicated, high-rise dwelling buildings directly exposed to sunlight would inevitably deteriorated indoor thermal comfort, as well as induce the heat island effect (Giridharan, Lau et al. 2007).

Figure 5- 38 Typical Plans of Dwelling Units of Case 2

According to the household survey and interviews, storage space was claimed to be insufficient. As a result, communal spaces such as the lift lobby, corridors and staircase were occupied by some residents for storage of their private items (Figure 5-39). Balconies have generally been incorporated into living rooms as response to the climatic condition as well as to maximize space. Except for a few dwelling units facing the urban park and the central garden, the majority of dwelling units do not have spectacular views, while many respondents felt a lack of privacy due to the small building spacing.

Figure 5- 39 Actual Use Conditions of Dwelling Units in Case 2
Left two: view from windows; Middle two: spatial living rooms and the French windows without safety railings; Right two: the balconies respectively used as storage space and leisure space. Source: photos taken by the author.

5.5 Case 3 (TianLin Garden): a high-rise housing estate dominated by short-slab high-rise dwelling buildings

Case 3 (TianLin Garden) is located in the Tianjin Old Town, which was first constructed in 1404 and has turned into a dilapidated slum area by the early 21st century (Wang and Zhang 2007). In 2003, despite of many objections, Tianjin Municipal Government commissioned the plan to redevelop the Old Town, and all buildings in the area was to be completely removed except for several important historic buildings (Figure 5-40). Due to the lack of public funds, the private sector was invited to carry out the development. The Old Town area was divided into 16 pieces of land, which were sold to private development companies for commercial development. Therefore, the renovation of Tianjin Old Town had become a government-led, developer-operated and profit-oriented development pattern with gentrification of the whole district. In eight years from 2003 to 2011, a brand new urban neighbourhood has almost been completed, housing mainly the middle- to high-income classes.

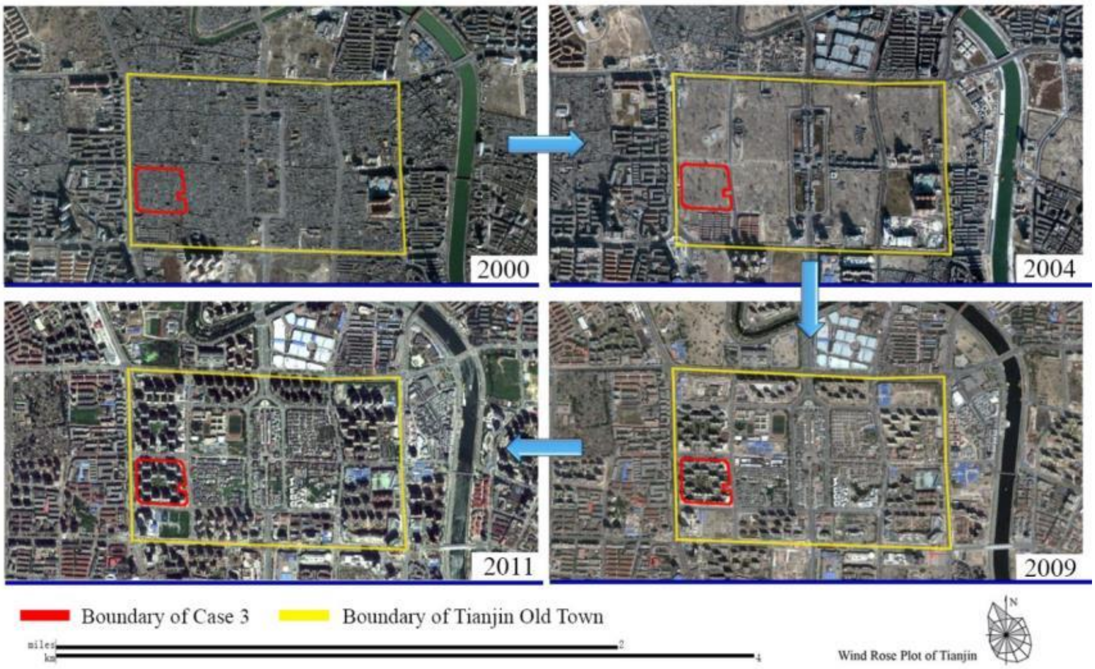


Figure 5- 40 Regeneration of Tianjin Old Town

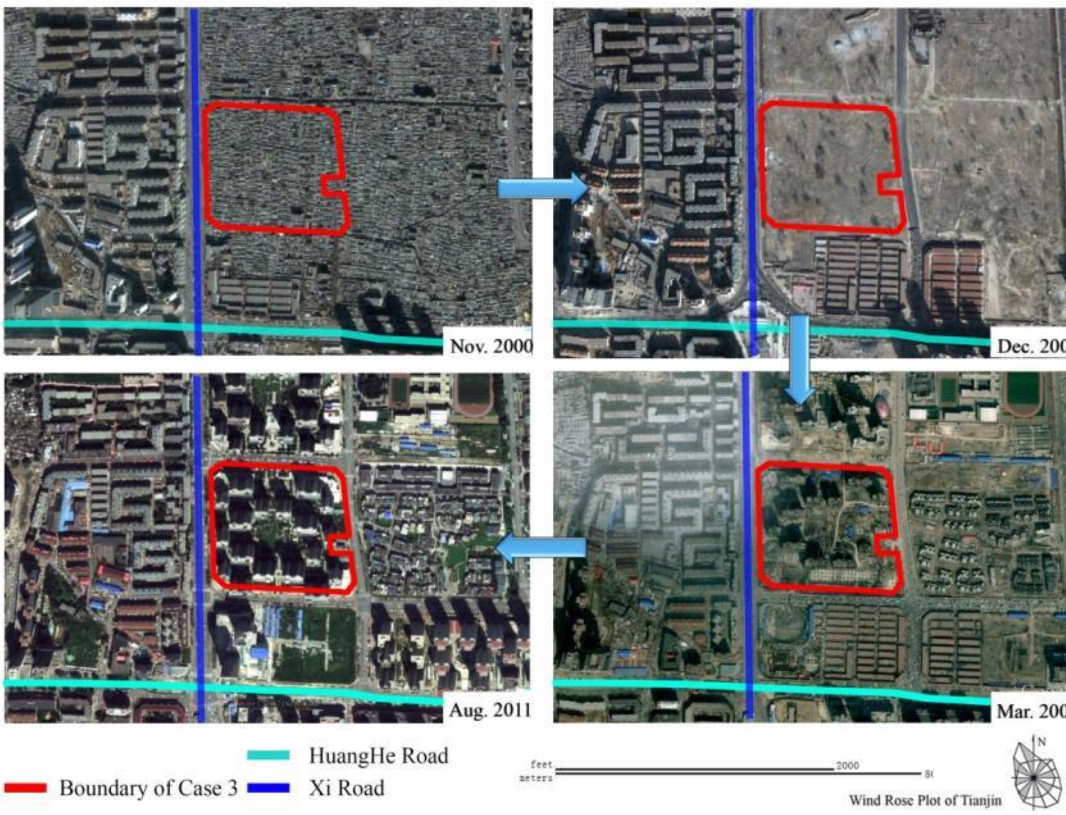


Figure 5- 41 Regeneration of the Surrounding Urban Neighbourhood of Case 3

Case 3 was the second phase of a series of commercial housing developments which started in August 2005 and was completed in October 2011 (Figure 5-41). Being developed by one of the largest real estate companies (GuangZhou R&F) with a standardized system of planning, design, construction and management, Case 3 is a representative of many similar housing developments in China. To maximize profit, the development company used the same design for most of their housing developments. However, it was found that, this may cause problems. As a real estate company based in South China, GuangZhou R&F was used to developing housing in the hot climate. Evidence from the interviews has shown that, the standardized design based on the climate of the South has been ill-adjusted to the climate of the North. For example, the manager of the estate-management company pointed out that the ramps leading to the entrances did not have non-slip treatment for snow and ice, and caused many accidents. Consequently, the developer had to transform the ramps into stairs. The tiles and slates used on the external walls of dwelling buildings, which performed well in the hot and humid climate of the South, began to peel and fall off after only a few years due to the cold and dry climate of the North - an indication of the lack of localized design intervention.

5.5.1 A brand new urban neighbourhood

As described earlier, Case 3 was located in **a brand new urban neighbourhood** that show trends of gentrification (Figure 5-42). Many ***public service facilities*** including schools, supermarket, upscale restaurant and shopping plaza, concentrated in the walking distance of 300 meters. Convenient ***public transportation*** (bus and metro) provided more travel options.

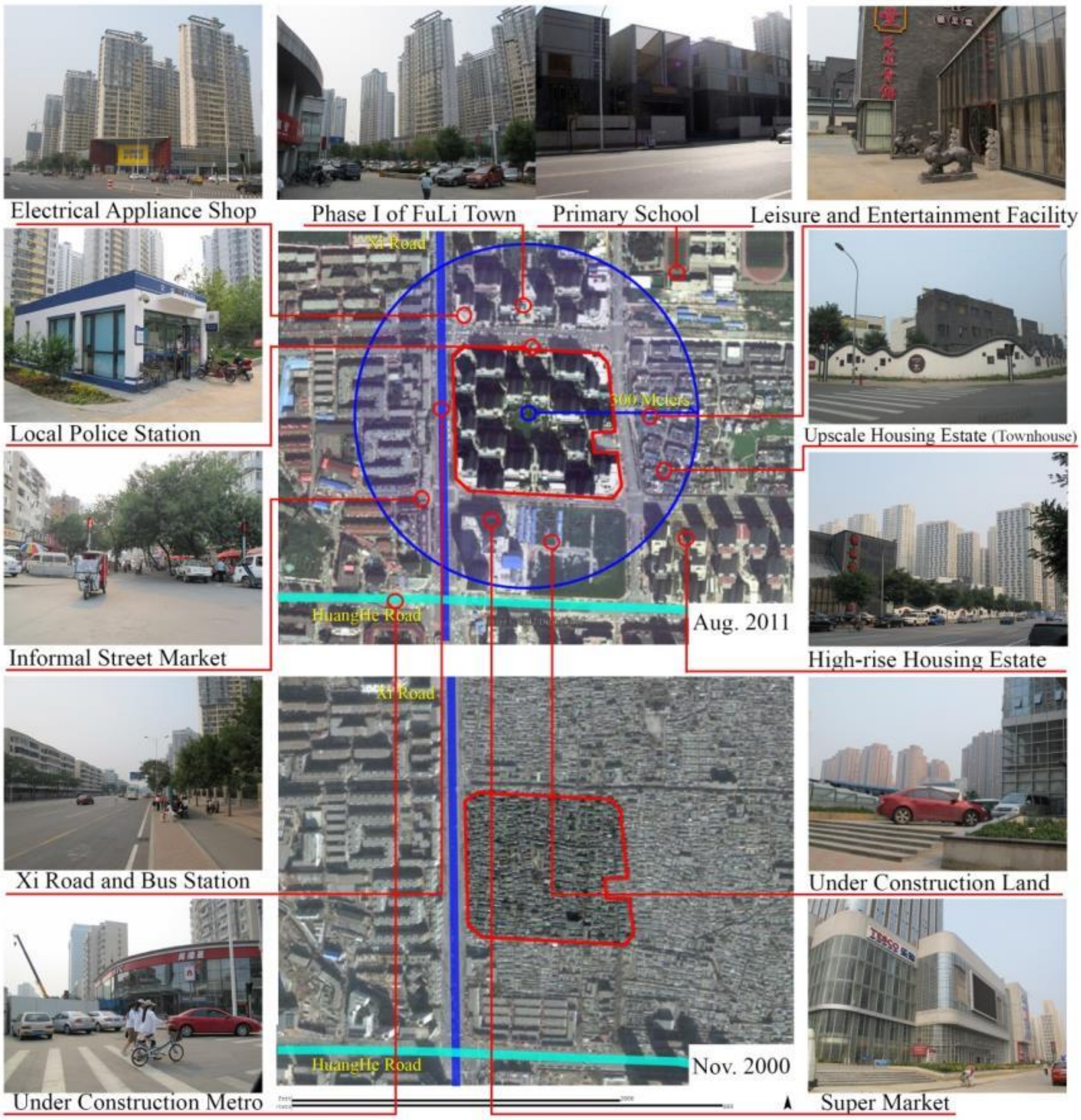


Figure 5- 42 General Conditions of the Surrounding Urban Neighbourhood of Case 3

Despite of a modern and glamorous image, few attractive ***public spaces*** can be found. With a spatial scale designed for automobiles, ***traffic noise*** and ***environment pollution*** further deteriorated the urban neighbourhoods. Moreover, the ‘new’ neighbourhoods show certain degrees of ***lack of maintenance*** (Figure 5-43). Although many interviewees expressed the dissatisfaction with ***public security conditions,*** most of them believed that they had strong ***neighbourhood attachment***.

Figure 5- 43 Environmental Issues of the Surrounding Urban Neighbourhood of Case 3

Left two: the dirty and damaged walkways; Middle two: the disrepair of the public facilities and the vacant shops; Right two: the crowed and chaotic old street but vibrant in the adjoining original neighbourhood. Source: photos taken by the author.

5.5.2 A housing estate with high development intensity and good landscape design and community management

Case 3 presents a typical housing estate with high development intensity and standardized design. It provided over 1,800 dwelling units on an area of about 6 hectares, with a plot area ratio of 3.92 and household density (306 households per hectare) much higher than case 1 and case 2. Case 3 offers the highest standard estate management, with the highest service charge and property price among the 4 cases (Table 5-10). It also provided ample parking spaces with a two-storey underground car park.

Case 3 is constituted of eighteen 27- to 28-storey short-slab dwelling buildings surrounding a large Chinese-style central garden (Figure 5-44). The bottom two storeys of the corner buildings are designed for commercial use. All dwelling buildings are north-south orientated, with building spacing between 18 meters (lateral spacing) and 90 meters (north-south spacing), as required by the fire safety interval (the minimum lateral spacing > 13 meters) and the insolation interval (1.2 times of the projected width of dwelling building on the south). The large spatial scale challenged the instinct requirement of residential function – a humanized living space as Jacobs appealed in her notable book: *the Death and Life of Great American Cities* (1961).

Table 5- 10 Development Data of Case 3

`Index		Unit	Nature
1	Time of Earth Breaking		Aug. 2006
2	Time of Delivering		Oct. 2008
3	Land Area of Housing Estate	Hectare	6.08
4	Residential Floor Area	M^2	238,148
5	Plot Ratio of Housing Estate		3.92
6	Average Building Height in Storeys	Storey	27.1
7	Insolation Interval		1.2W*
8	Net Residential Building Density	%	14.5
9	Green Area Ratio	%	31
10	Parking Space per Household		1.1
11	Number of Parking Spaces		2,029
12	Number of Households		1,861
13	Household Density	Household/Ha.	306
14	Property Service Charge	RMB/M^2.Month	2.2
15	Residential Building Forms	18 short-slab high-rise housings (27 to 28 storey)	
* W: Width of building = Projected width on the south The exchange rate between the British Pound and the RMB is about 1/10.			

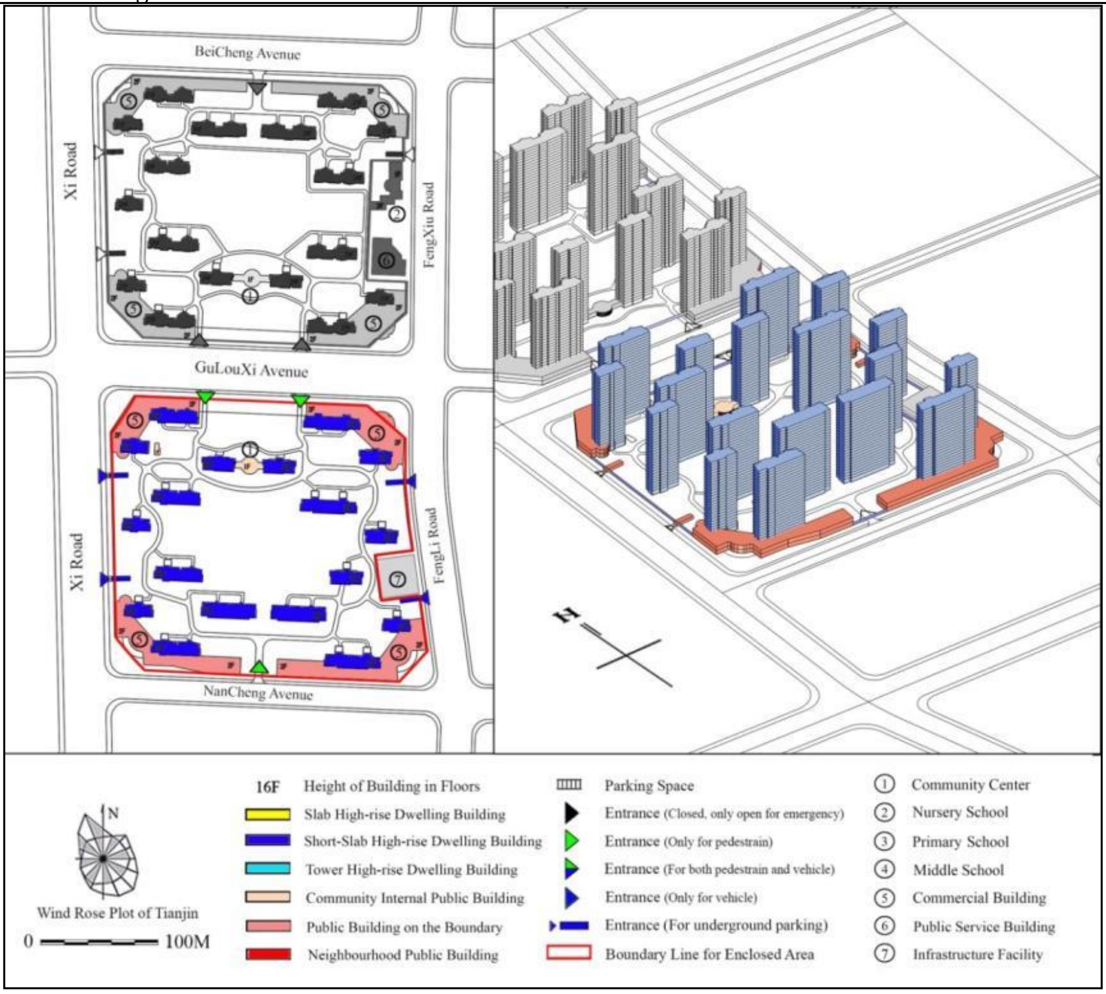


Figure 5- 44 Planning Layout of Case 3
Source: drawn by the author according to the project archive of Tianjin Planning Bureau

The estate was design to be a gated community with three pedestrian entrances and 4 vehicle entrances, all of which being monitored 24/7 (Figure 5-45). In order to cut on maintenance cost, only two of the vehicle entrances were kept open. For the same reason, the water features near the main entrances were seldom used. The commercial space on each corner of the estate has shop fronts facing the outer neighbourhood, which has now been dictated by wide avenues and high-rise buildings. Safety concerns provoked by the high-speed traffic immediately outside the estate have been widely expressed - a situation that further reinforced the necessity of more gated community.

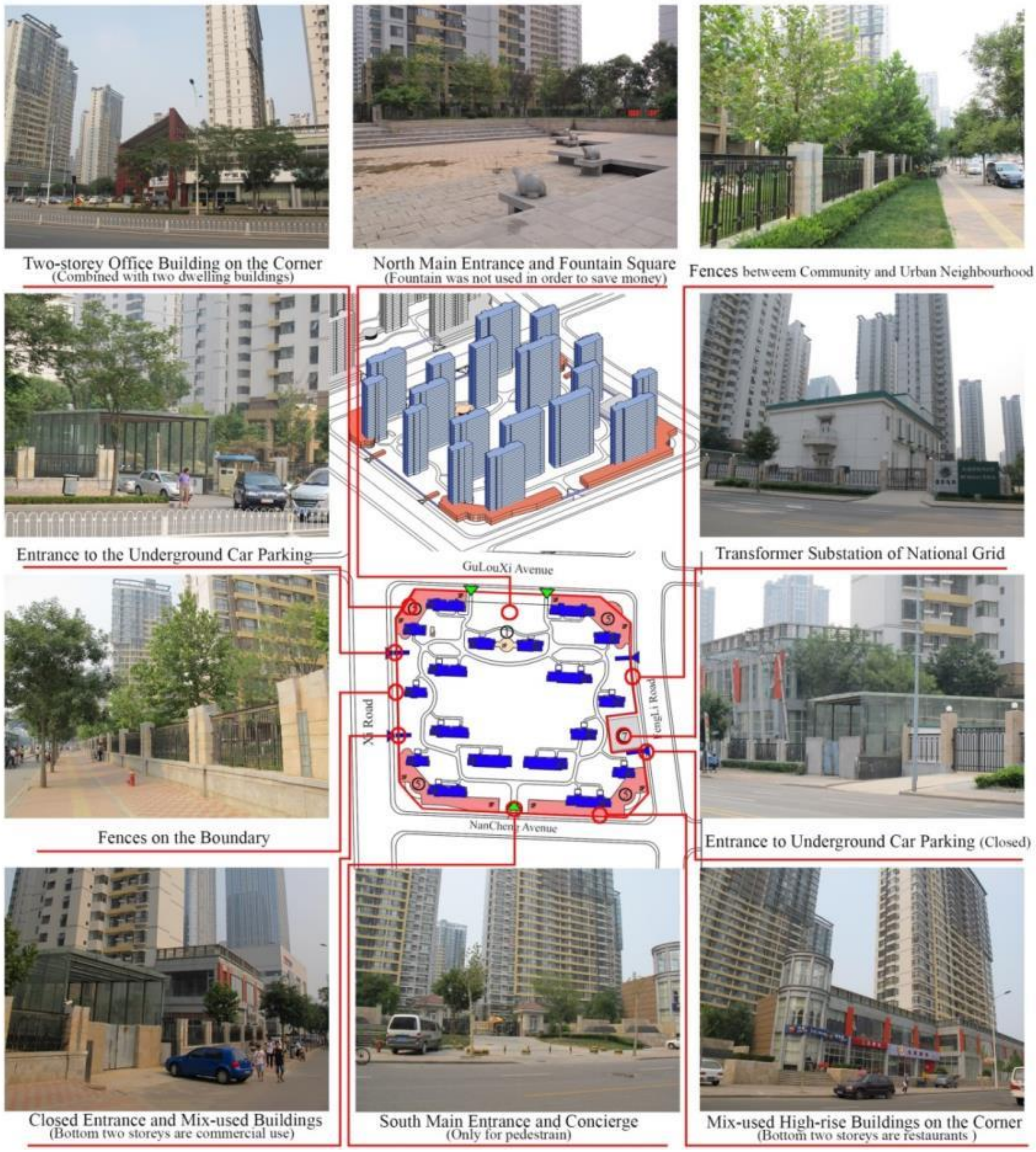


Figure 5- 45 Boundary and Entrances of Case 3

Case 3 adopted a ***three-dimensional pedestrian-vehicle-separated internal traffic system*** that consists of the underground floor for vehicles and the ground floor for pedestrians and cyclists (Figure 5-46). This traffic system indeed formed a pedestrian-friendly internal environment, however at the cost of high construction and maintenance cost of both underground car park and ground floor landscape, such as lighting, ventilation and roof gardening. These costs were finally bared by the residents, which was one of the reasons for higher service charge than the other three cases.

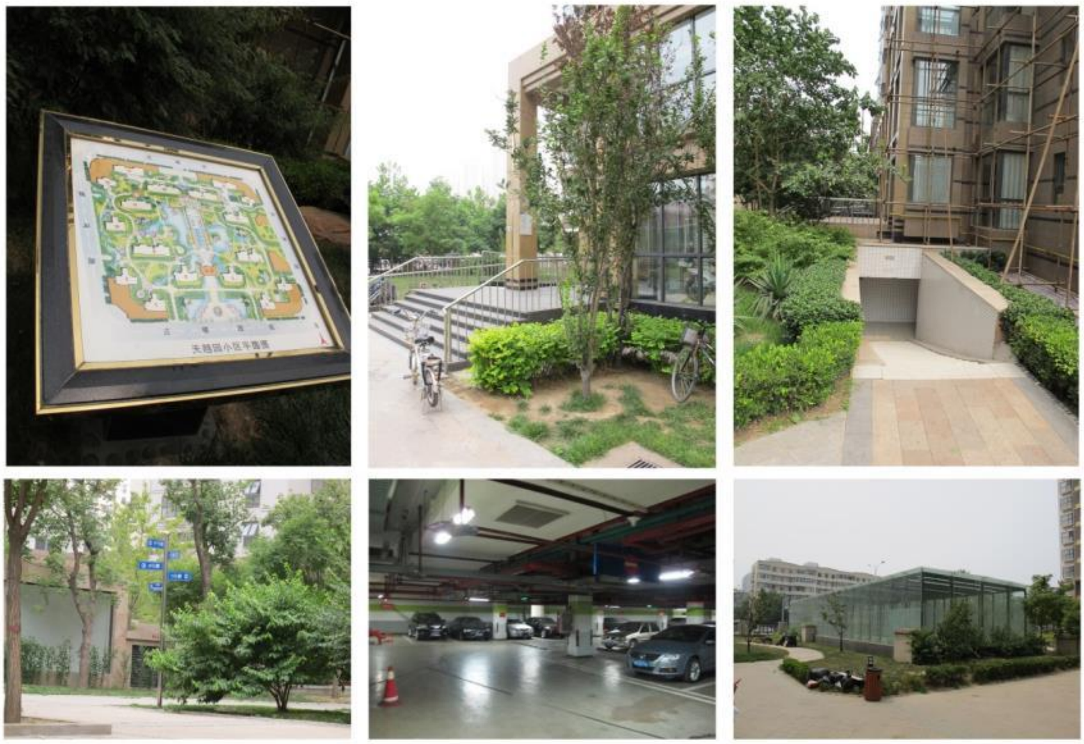


Figure 5- 46 Internal Traffic System of Case 3

Left two: the map and tag system; middle two: lack of ground bike parking and sufficient underground car park; right two: cyclist and vehicle entrances to underground bike and car park.

Although the green area ratio of Case 3 was not the highest among the study cases, (just 1% above the lowest standard of 30% as stipulated in the *Code of Urban Residential Areas Planning & Design* (CAUPD 2002)), the central Chinese style garden with plenty of greenery formed a high quality landscape on the roof of the underground car park (Figure 5-47). The central garden consisted of a large pond and leisure facilities such as arbour, vestibule and chairs, which provided a beautiful pedestrian-friendly leisure space. The central garden improved the internal environment. However, noise impact has been reported due to the lack of noise-shielding obstructions such as plantings along the boundaries of the estate. Moreover, compared with case 1 and case 2, the facilities and activity space for children and the elderly were inadequate because of the significantly higher population density. Although the community centre provided indoor space and facilities including swimming pool and gym, usage of these facilities are limited due to the expensive charge.

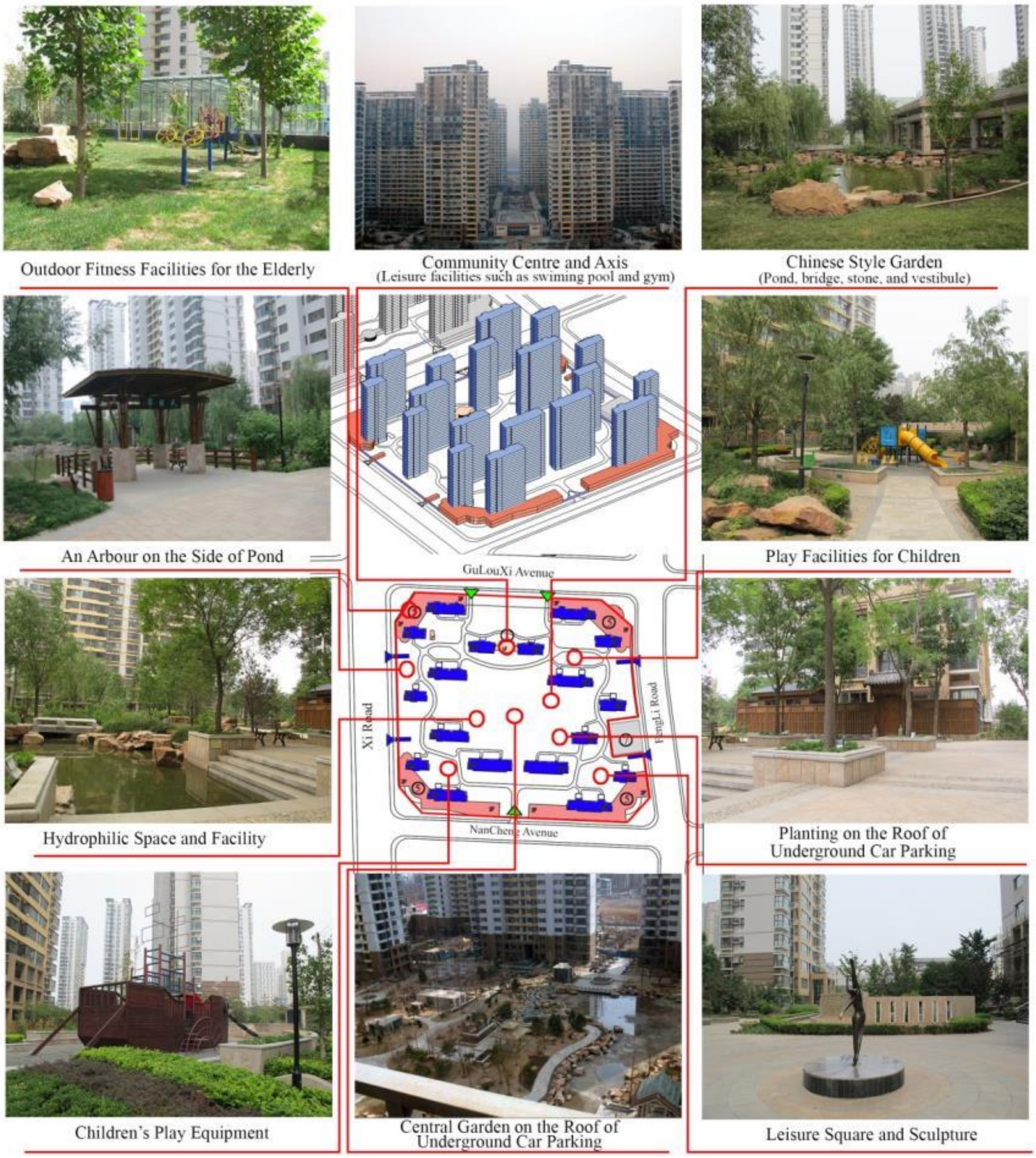


Figure 5- 47 Landscapes and Public Facilities of Case 3

With the highest property service charge among the 4 cases, maintenance and management of the community indeed have a relatively higher standard. Like many managed residential estates, disputes exist between the estate management company and the residents. This is partly due to the general lack of trust between consumers and the service industries, and partly due to the inadequate legislation and regulation in the area of estate management in China. Furthermore, due to construction quality problems, some of the wall tiles of the dwelling buildings fell down in the extreme weathers with strong wind. Although the developer was quick to repair the damaged external walls, the incident has raised a prevailing public concern on the safety of high-rise housing estates. The shortage of ground-level bike parking was another issue, which resulted in some bikes being parked in the lobbies and corridors of the dwelling buildings (Figure 5-48).

Figure 5- 48 Problems of Management and Maintenance of Case 3
Left: repairing the wall tiles; Right top: banners hung on the building to protest against the developer; Right bottom: the bike was locked on the railing of the entrance.

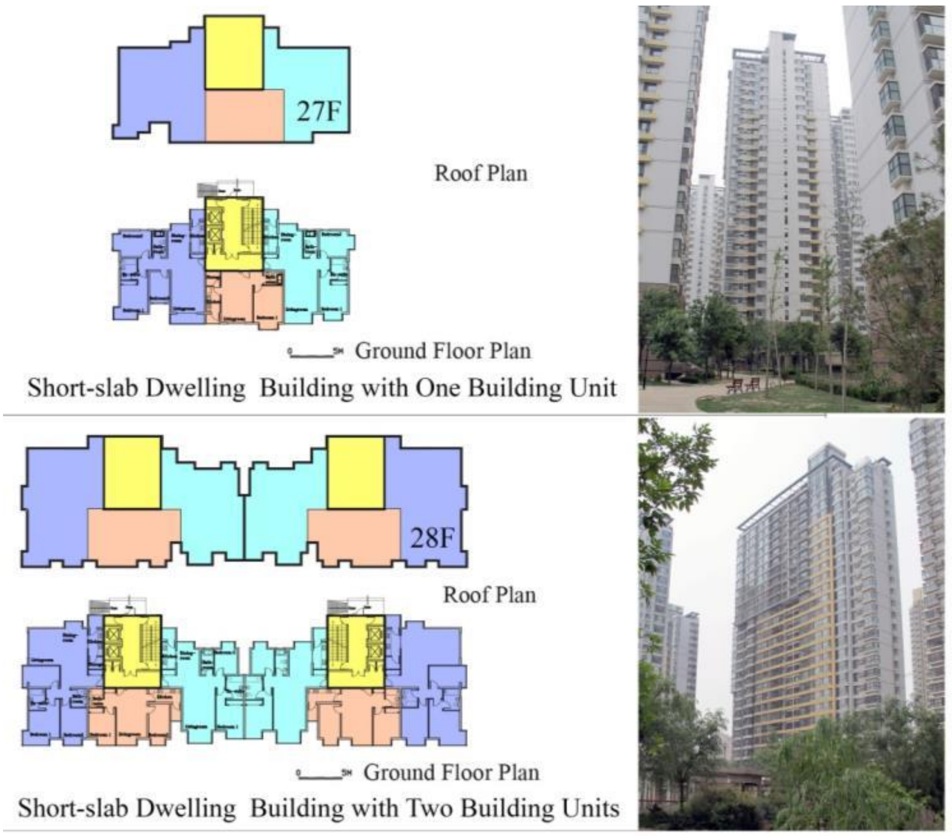


Figure 5- 49 Two Typologies of Short-slab High-rise Dwelling Building in Case 3

5.5.3 The simplex short-slab high-rise dwelling buildings

Case 3 was consisted of eighteen short-slab dwelling buildings (Figure 5-49). The **household density** ranged from 56 (2 dwelling units per floor over 28 storeys) to 84 households per dwelling building (3 dwelling units per floor over 28 storeys). On each floor, two or three dwelling units shared two lifts and a communal lobby and corridor, which achieved a similar household density with slab high-rise dwelling building while increasing the development intensity of the whole estate due to the much higher storeys.

The dwelling buildings of case 3 adopted **the standardized design** based on the planning and design system of the developer itself. The standardized design pattern adopted monotonous architecture design for housing development so as to maximize profit. As a result, community identity is poor. However, the standardized design approach is not without merits. It has provided mature detailed designs such as barrier-free design and good quality design of interior communal spaces such the lobbies and corridors (Figure 5-50).

Figure 5- 50 Luxury Entrance, Lobby and Interior Design in Case 3
Top three: the grand entrance and lobby; Bottom three: the decoration, reception desk, and elevator hall. In order to save money, the porter was no longer in post, but the maintenance of the communal spaces and facilities was still on a high level.

Moreover, some residents stored their bikes and private stuffs in the communal corridors and stair wells, which not only influenced the use of the other residents but also formed safety and security risks in the high-density residential environment (Figure 5-51). These phenomena reflected the shortage of storage space of dwelling units and the concerns of security management, especially for bicycle theft. The interviewees of case 3 generally complained the security conditions in spite of monitoring with CCTV and guardianship of concierges.

Figure 5- 51 Usage of the Communal Spaces in Dwelling Buildings of Case 3

5.5.4 The luxury dwelling units with standardized design

The average floor area of dwelling units in case 3 is 128 square meters, which is the largest among the 4 cases. In China, all residential properties are sold at prize per m^2, therefore, larger unit size generally means higher property value. The average price per square meter of dwelling units in Case 3 is 20300 RMB in 2011, while the overall average price in the inner city of Tianjin was 17060 RMB in the same year

(Soufun.com 2012). The price level of Case 3 was just slightly lower than case 2, while its average rental price was the highest among the 4 cases.

Based on the size, orientation and ventilation, the dwelling units of Case 3 can be grouped into five categories (Table 5-12). The proportion of two-bedroom dwelling units was close to 60%, and the percentage of large dwelling units is 31% (24% of three-bedroom apartment and 7% of 4-bedroom apartment). Compared with case 2, the floor areas of the various dwelling units were larger.

Table 5- 11 Economic Data of Dwelling Unit in Case 3

Index			Case 3	Average Level
1	Average Floor Area per Dwelling unit (M^2)		128	97.6
2	Original Average Price (RMB/M^2)		9100 (2007)	6200 (2007)
3	Average Price in 2011 (RMB/M^2)		20300	17060
4	Average Rental in 2011 (RMB/Month)	One-Bedroom	2700	1755
		Two-Bedroom	3500	2230
		Three-Bedroom	5100	4165
The exchange rate between the British Pound and the RMB is about 1/10. The annual per capita income in Tianjin was 26,921 RMB in 2011 (SONBS 2011).				

Source: compiled from the project archives of Tianjin Planning Bureau, the data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Centre of Soufun.com Limited

Table 5- 12 Distribution of Different Types of Dwelling Units of Case 3

Case 3: TianLin Garden (Phase II of FuLi Town)– Dominated by short-slab high-rises								
Size	**Orientation**	**Ventilation**	**Building Form**	**Typology of layout**	**Range of floor area**	**Amount**	**Proportion (%)**	
One-Bedroom	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	2	55-65	243	13	13
Two-Bedroom	North-South	Good natural cross-ventilation	Short-slab high-rise	5	80-115	555	30	56
	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	4	75-110	487	26	
Three-Bedroom	North-South	Good natural cross-ventilation	Short-slab high-rise	5	120-150	439	24	24
4-Bedroom	North-South	Good natural cross-ventilation	Short-slab high-rise	2	180-190	137	7	7

From the perspective of dwelling unit layout, the proportion of family living space was higher than those of the other three cases, and the combination of living room and dining room effectively improved the sense of space (Table 5-52). The majority of dwelling units have two bathrooms, which was another characteristic differing from the other cases. However, in order to increase the development intensity, almost half of the two-bedroom apartments were without cross-ventilation. Another important weakness was the lack of storage spaces, which was a common problem found in all study cases.

Figure 5- 52 Typical Layout Plans of Dwelling Units of Case 3

According to the site survey and interviews, the small building spacing has led to concerns over privacy and views (Figure 5-53, top two). Moreover, the large French windows without safety railings are a potential safety issue especially for the children and the elderly despite providing better natural lighting. Because of the shortage of auxiliary space, the balconies and bathrooms were often used as storage spaces (Figure 5-53, bottom three).

Figure 5- 53 Actual Use Conditions of Dwelling Units in Case 3

5.6 Case 4 (BaoLong Bay): a high-rise housing estate with mixed short-slab and tower high-rise buildings

Case 4 (BaoLong Bay) was developed from September 2006 to November 2008 by a medium-sized local private developer (Figure 5-54). The site of Case 4 was originally dominated by traditional courtyard houses before the new development. The area was poorly serviced with urban infrastructure. The old neighbourhood was mixed with industrial and commercial buildings. According to the archive of Tianjin Planning Bureau (TUPDI 2005), the majority of the old houses fell into disrepair, and the industries were closed due to bankruptcy. Therefore, all of the original buildings within the site had been demolished in 2005. Because the neighbourhood surrounding Case 4 was located on the administrative boundary between Nankai District and Hebei District, the regeneration of the whole area lacks unified planning. In China, urban planning and development was led by the government, the administrative border areas were easy to be ignored due to the conflict of interest and the difficult of cooperation between stakeholders. Consequently, the regeneration usually made slow progress and was sometimes even chaotic (Lu 2004, CAUPD 2005).

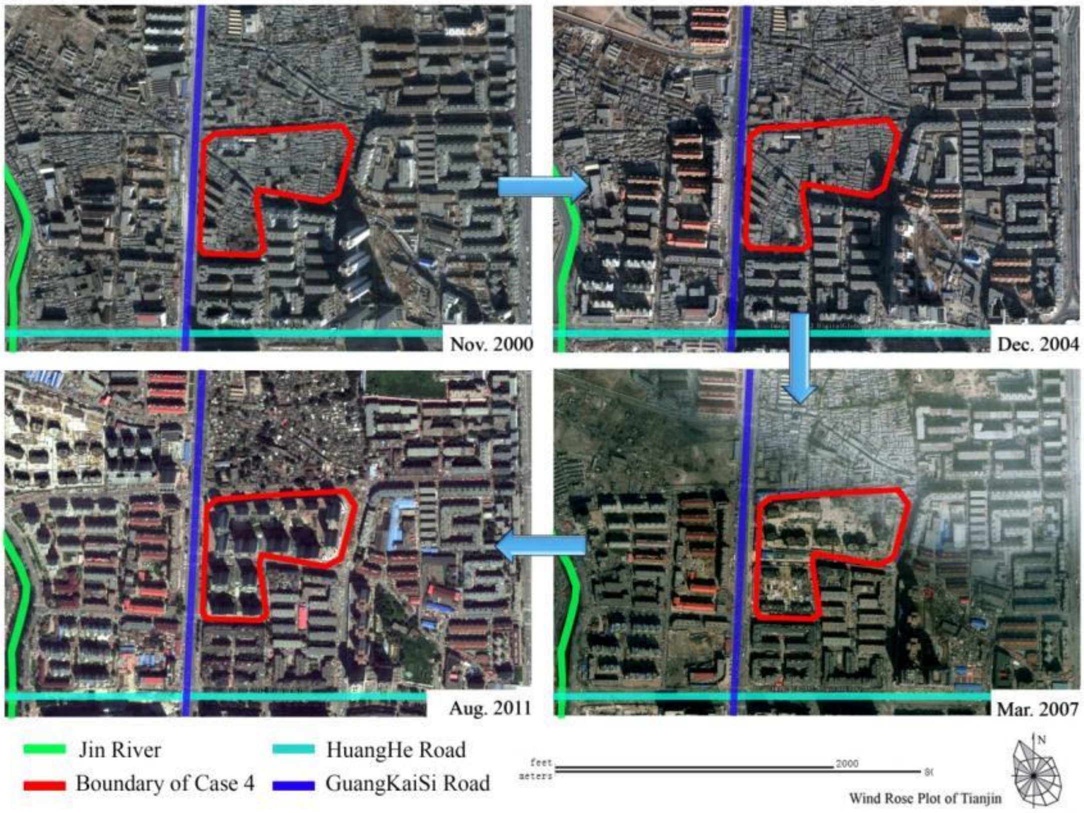


Figure 5- 54 Regeneration of the Surrounding Urban Neighbourhood of Case 4

5.6.1 A urban neighbourhood under regeneration

Being on the administrative boundary of two urban districts, Case 4 presents a specific case with **a neighbourhood under regeneration**. Its surrounding neighbourhoods demonstrate a state of somewhat chaos and informality with **shortage of local public space and service facilities**, especially urban parks, nurseries and primary schools. As Figure 5-55 showed, no significant public facility can be found within walking distance (300 meters) to the estate. On the north of the estate, a large-scale traditional urban neighbourhood was being demolished as part of inner city slum clearance. A new high-rise housing estate was planned to be developed here. Another high-rise housing estate on the north-west has just been completed. The other adjoining sites were the Soviet-style residential quarters that were built in 1980s, when the multi-storey dwelling buildings with north-west orientation were planned and designed to improve the development intensity (Liu and Shao 2001). Some old tower high-rise dwelling buildings were located in a residential quarter on the south-east, which were welfare housing of a state-owned enterprise.

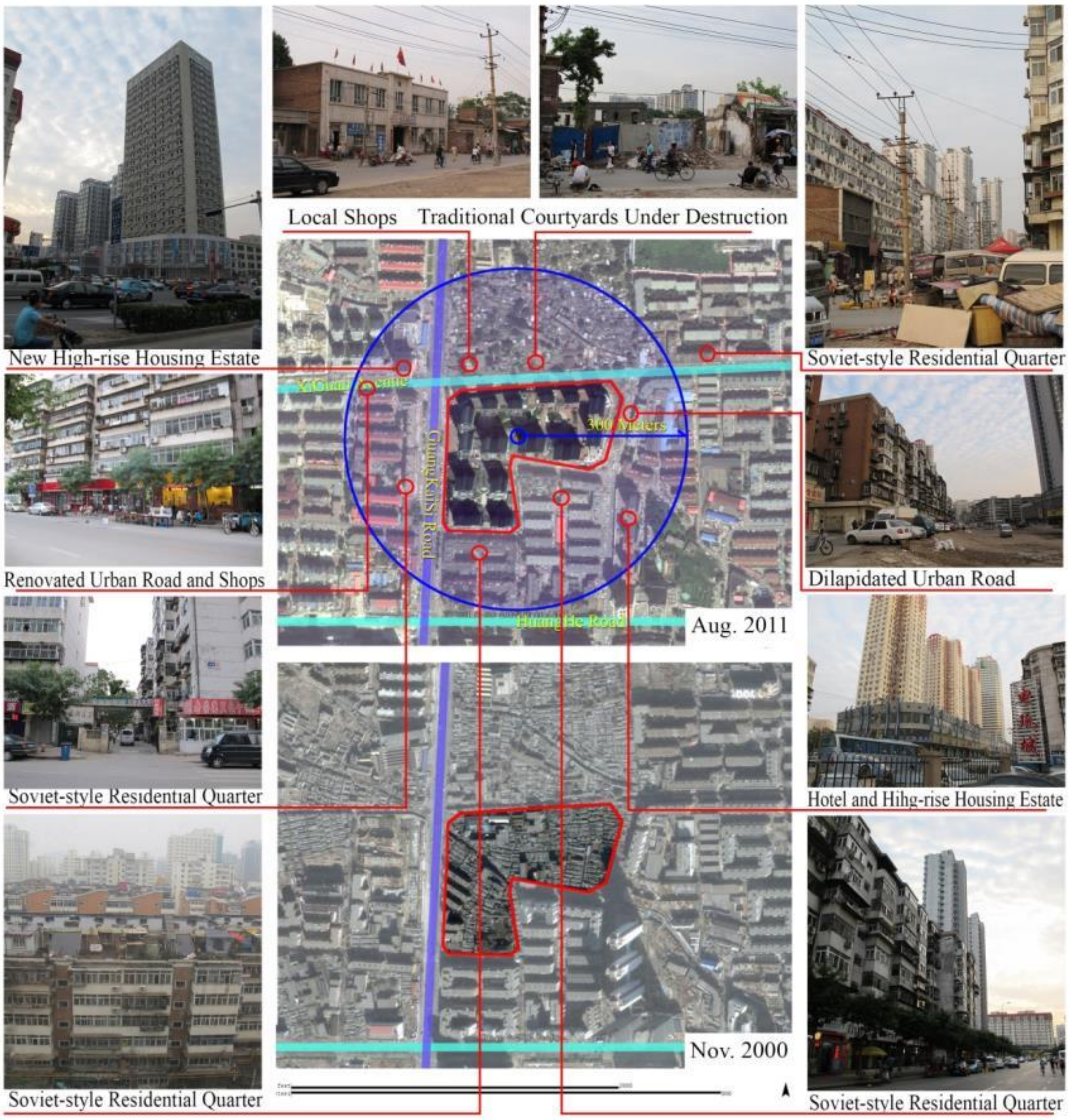


Figure 5- 55 General Conditions of the Surrounding Urban Neighbourhood of Case 4

Tidiness and maintenance of the neighbourhood environment was one of the serious problems identified by the residents. Garbage and waste water are exposed on the streets (Figure 5-56, Right two); Necessary facilities including streetlight and road safety barriers were not installed (Figure 5-56, Middle two); Pedestrian walkways and urban landscape were out of repair (Figure 5-56, Left two). Many interviewees complained about **the poor public security conditions** due to the recurring bike theft and burglary. The disrepair urban roads resulted in **the chaos traffic conditions**, and **traffic and construction noise also** caused widespread dissatisfaction. Despite of those problems, the majority of interviewees expressed high **neighbourhood attachment**.

Figure 5- 56 Environmental Issues of the Surrounding Urban Neighbourhood

5.6.2 A housing estate with high development intensity and poor planning and community management

Case 4 is the smallest one among all study cases, with a land area of 3.85 hectares housing1552 households. The plot area ratio is 4.09, and the household density is 403 households per hectare, which has the **highest development intensity** among the 4 cases (Table 5-13). Similar to the other cases, Case 4 is a gated community managed by a property management company owned by the developer. The property service charge was at a moderate level (YJDC 2011). Based on the new provision of urban housing development, the parking space per household of Case 4 was planned to be 1.1. To achieve a balance between construction cost and car parking demands, the underground car park has been designed to accommodate 50% of all parking lots, with the other 50% scattered within the community space. As a result, the whole estate appears to be surrounded by parking lots.

Table 5- 13 Development Data of Case 4

`Index		Unit	Nature
1	Time of Earth Breaking		Sep. 2006
2	Time of Delivering		Nov. 2008
3	Land Area of Housing Estate	Hectare	3.85
4	Residential Floor Area	M^2	157,650
5	Plot Ratio of Housing Estate		4.09
6	Average Building Height in Storeys	Storey	24.8
7	Insolation Interval		1.2W②
8	Net Residential Building Density	%	16.5
9	Green Area Ratio	%	30
10	Parking Space per Household		1.1
11	Number of Parking Spaces		1,479
12	Number of Households		1,552
13	Household Density	Household/Ha.	403
14	Property Service Charge	RMB/M^2.Month	1.8
15	Residential Building Forms	13 short-slab high-rise housings (18 to 28 storey) 2 tower high-rise housings (32 storey)	
* W: Width of building = Projected width on the south The exchange rate between the British Pound and the RMB is about 1/10.			

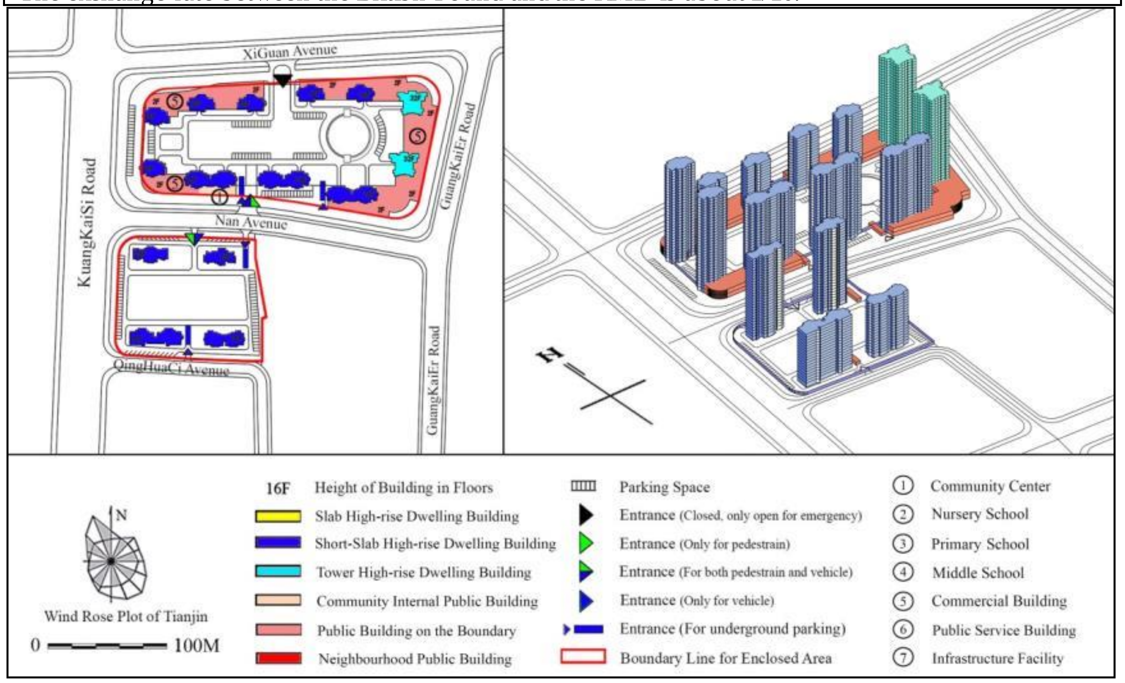


Figure 5- 57 Planning Layout of Case 4
Source: drawn by the author according to the project archive of Tianjin Planning Bureau

Case 4 consists of two gated estates separated by a neighbourhood street (Figure 5-57). Both estates have similar layouts with all dwelling buildings located near the boundary and surrounding a central garden. Nine mixed-use short-slab dwelling buildings from 18- to 32-storey and two 32-storey tower buildings that combined with three 2-storey commercial buildings encircled the north estate, while 4 short-slab dwelling buildings (18-storey and 28-storey) constituted the south estate. It was worth noting that: the two towers, consisting of the dwelling units with smaller size and cheaper price, were built for ***the original residents*** as a compensation of their old house in this land, and ***the families*** who preferred to live in city centre but without enough high incomes; the short-slab dwelling buildings with higher price were focused on the property buyers who had relatively high income and paid more attention to residential environment quality.

Figure 5- 58 Boundary and Entrances of Case 4

Both the north and south parts were gated communities managed and maintained by the same company. The north part was planned with two entrances to the underground car park and four entrances for both vehicles and pedestrians, but three out of four entrances were closed (Figure 5-58). According to the interviews with the manager of the property management company and the residents, there were two main reasons to cause the situation: 1) the regeneration of the surrounding neighbourhood have not been completed, especially the north and west roads are under construction, thus the entrances were temporarily closed; 2) due to the low occupancy rate (only 50% according to the data of the property company) and low payment rate of property charge (vicious circle: poor service -- less payment – worse service), the company was not able to hire enough employees to manage those entrances. Half of the commercial buildings were still vacant.

Figure 5- 59 Internal Traffic System of Case 4
Left two: the lighting well and entry of underground car park; Middle two: the internal roads and park plots; Right two: the mixed-pedestrian-vehicle roads and the accessible ramp occupied by bikes.

Case 4 adopted a ***mixed-pedestrian-vehicle internal traffic system***. Because of the sufficient parking spaces in the periphery and the underground car park, few cars parked in the community, which to some extent helped form a pedestrian-friendly internal environment (Figure 5-59). Similar with case 3, the large-scale underground car park and ground-level landscape resulted in high construction and maintenance costs, which were finally bared by the residents. Conflicts between the residents and the estate management company often arise over maintenance issues and the payment of the rather high service charge and parking fees.

The green area ratio of Case 4 met the lowest standard of 30% according to the provision of the Code of Urban Residential Areas Planning & Design (CAUPD 2002). Because the underground car park covered the entire site, the landscape and planting were exclusively on the roof of the car park, which resulted in the high cost of maintenance and gardening. Consequently, the central garden was largely covered in hard surface (Figure 5-60).

Figure 5- 60 Landscapes and Public Facilities of Case 4

The basic facilities for the elderly and children were inadequate. Residents found it difficult to find a place to sit and rest in the outdoor space, which resulted in the lack of space for social interaction between community residents. The central square became the main social place where residents stood chatting while supervising their children playing (Figure 5-60). The public service facilities such as waste transfer station were poorly maintained. In general, the standard of the landscape and facilities were significantly lower than the other three cases, while the level of property charge was at a similar level. (Higher than case 1 and case 2, and increased to the same level as Case 4 in 2011).

5.6.3 The mixed short-slab and tower high-rise dwelling buildings

Case 4 consists of two types of **building forms**: short-slab and tower high-rise dwelling buildings (Figure 5-61).

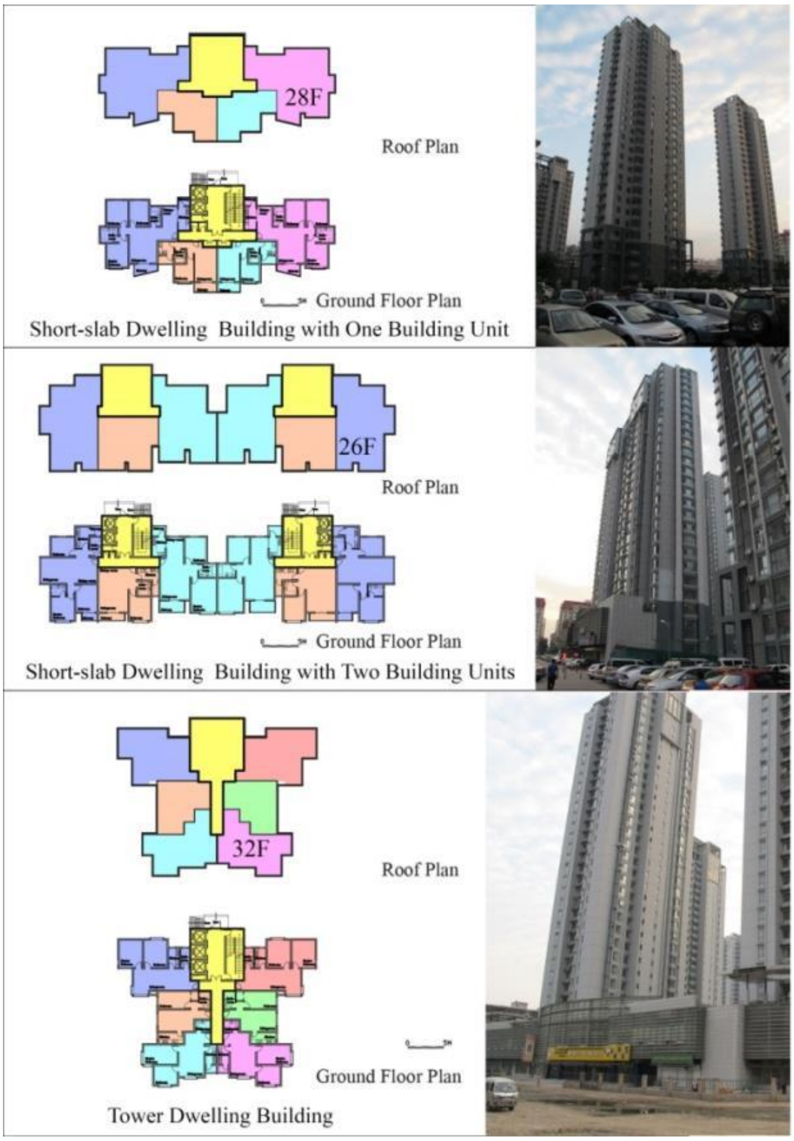


Figure 5- 61 Short-slab and Tower High-rise Dwelling Buildings in Case 4

The former include six 18-storey dwelling buildings, three 26-storey dwelling buildings, two 28-storey dwelling buildings and two 32-storey dwelling buildings. The number of dwelling units in each building unit ranged from 54 (3 dwelling units per floor over 18 storeys) to 116 households (4 dwelling units per floor over28 storeys). There are also two tower dwelling buildings, both 32 stories. The **household density** of the tower dwelling buildings are 192 households (6 dwelling units per floor over 32 storeys).

Figure 5- 62 Outdoor Units of Air Conditioners Fixing on the External Walls

Although these dwelling buildings have different layouts and heights, the **facade design** adopted the same materials and colours, and formed a uniform community image. All of the interviewees complained about the grungy design of the spaces for air conditioner outdoor units. Because the size of the platform was too small for a standard air conditioner unit, residents have to fix them on the external walls (Figure 5-62), which not only resulted in the difficulty of installation and maintenance especially for higher floors, but also increased the safety risk and destroyed the building facade from both functional and aesthetic aspects.

Intercom systems were installed at the entrances of dwelling buildings to control access. **Barrier-free design** with ramps for the elderly and disabled are widely adopted (Figure 5-63). The mailboxes and garbage bins are placed nearby the entrances, but separate wastes collection has not been adopted. The communal lobbies and corridors were compact and simple without any decorations. The corridors are also dark without natural lighting and ventilation. Generally speaking, the design, management and maintenance of the dwelling buildings in Case 4 were little more than meeting basic functions.

Figure 5- 63 Entrances and Communal Spaces and Facilities of Dwelling Buildings in Case 4

Each dwelling building provided an underground bicycle park, but many residents were not willing to store their bikes in these bike parks due to the high crime rate of bike theft, and they preferred to lock their bikes on the railings of entrances or store them in the lobbies and corridors in their dwelling buildings (Figure 5-64). Many interviewees expressed dissatisfaction with the security management of the estate. The monitoring system including CCTV and intercom were often out of order, and the estate management company acclaimed that they need higher service charge to maintain and improve the security equipment. Although the reasons for the conflicts between residents and the property management company were complicated, the high cost of high-rise living and the negative impacts of high-density housing undoubtedly played an important role.

Figure 5- 64 Issues on Bike Parking in Case 4
Right two: residents locked their bikes on the railings of the entrance; Left top: residents stored their bikes in the communal lobby; Left bottom: the ramp to underground bike park.

5.6.4 The economical dwelling units with basic design

The average floor area of dwelling units in Case 4 is 102 square meters, which is the smallest among the 4 cases. The average price per square meter of dwelling units was the lowest among the 4 cases. It was worth noting that the original price of Case 4 was above the average level of the inner city in 2007, but the price in 2011 dropped below average level, which indicates that the market value of Case 4 has significantly decreased (Table 5-14).

Table 5- 14 Comparison of Economic Data of Dwelling Unit of Case 4

Index			Case 4	Average Level
1	Average Floor Area per Dwelling unit (M^2)		102	97.6
2	Original Average Price (RMB/M^2)		8500 (2007)	6200 (2007)
3	Average Price in 2011 (RMB/M^2)		15300	17060
4	Average Rental in 2011 (RMB/Month)	One-Bedroom	1800	1755
		Two-Bedroom	2400	2230
		Three-Bedroom	3200	4165
The exchange rate between the British Pound and the RMB is about 1/10. The annual per capita income in Tianjin was 26,921 RMB in 2011 (SONBS 2011).				

Source: compiled from the project archives of Tianjin Planning Bureau, the data in Tianjin Land Resources and Real Estate Information Network and in Online House Property Assessment Centre of Soufun.com Limited

There are 6 different types of dwelling units (Table 5-15). The proportion of small flats with one and two bedrooms is 81%, of which 32% were north-south oriented and cross-ventilated. On the other hand, all of the three-bedroom flats were north-south orientated and cross-ventilated. In general, the dwelling unit size of Case 4 was smaller than those of the other three cases.

Table 5- 15 Distribution of Different Types of Dwelling Units of Case 4

Case 4: BaoLong Bay – Mixed short-slab and tower high-rise housing estate								
Size	**Orientation**	**Ventilation**	**Building Form**	**Typology of layout**	**Range of floor area**	**Amount**	**Proportion (%)**	
One-Bedroom	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	2	65-80	156	10	18
	All windows facing West/East	Poor natural cross-ventilation	Tower high-rise	1	65-80	120	8	
Two-Bedroom	North-South	Good natural cross-ventilation	Short-slab high-rise	3	90-115	372	32	63
	All windows facing South	Poor natural cross-ventilation	Short-slab high-rise	3	85-110	236	15	
	Corner location	Poor natural cross-ventilation	Tower high-rise	2	85-90	240	16	
Three-Bedroom	North-South	Good natural cross-ventilation	Short-slab high-rise	5	115-140	428	19	19

The layouts of the dwelling units were also more compact than the other cases (Figure 5-65). In order to improve the overall economics, the orientation and ventilation of certain functional spaces such as bathroom and kitchen were compromised in the small flats. Especially in the tower high-rise dwelling buildings, the living-rooms and bedrooms of some flats were oriented to the west or north, which inevitably compromised indoor thermal comfort.

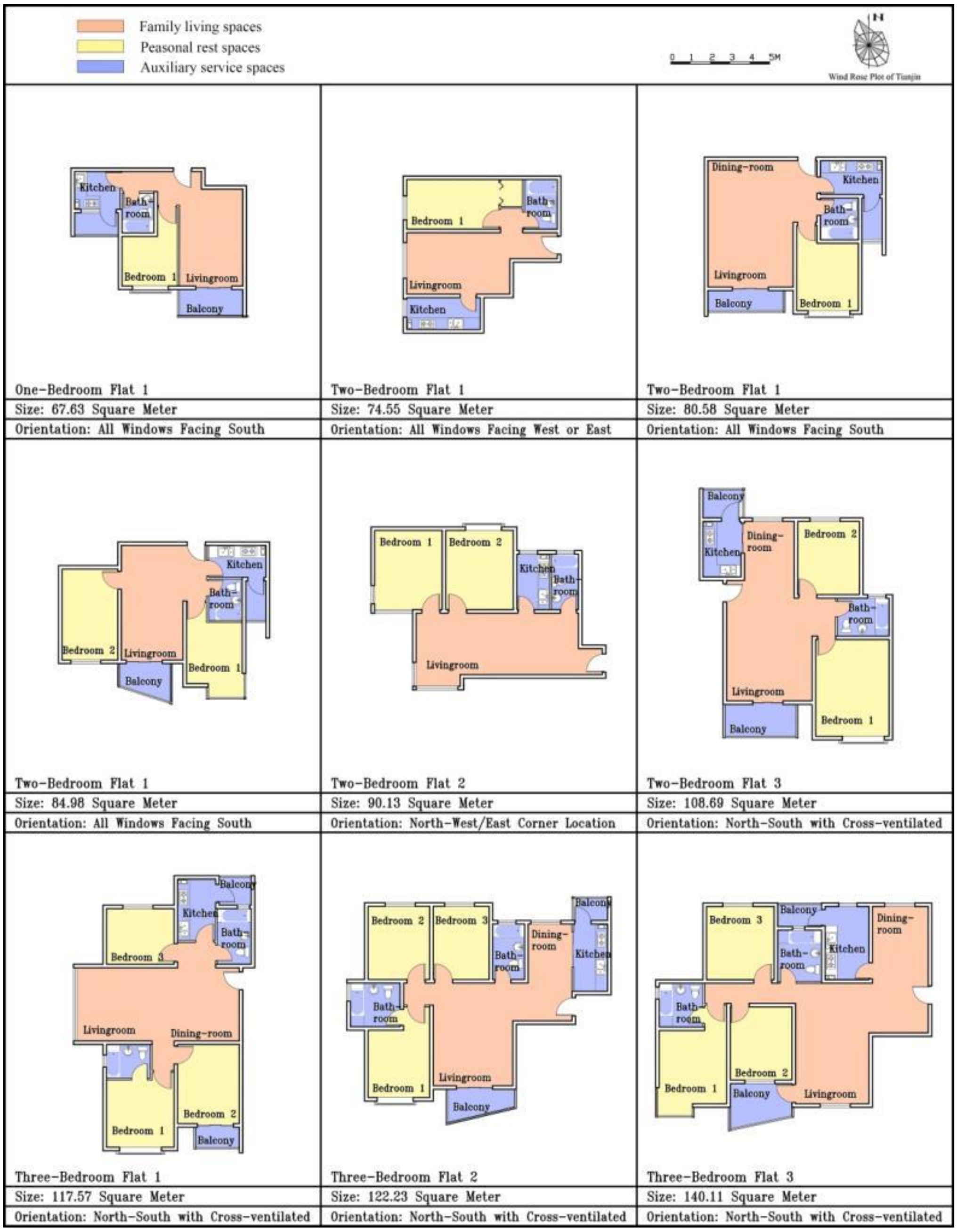


Figure 5- 65 Typical Layout Plans of Dwelling Units of Case 4

The interviewees were very dissatisfied with the west exposure of the living rooms with big French windows. According to their experiences, in the afternoon of hot summers, the indoor temperature can easily exceed 40 degrees Celsius. Moreover, the shortage of storage spaces directly impacted the daily life, and many residents had to store their stuffs in the balconies and the kitchen (Figure 5-66). The small flats usually had the least favourable natural lighting and window view. The expensive service charge and expenditures such as power and heating fee were complained by many interviewees, and the dissatisfaction with the property service exacerbated this complaint.

Figure 5- 66 Actual Use Conditions of Dwelling Units in Case 4
Right two: the views from windows; Middle two: the relatively poor natural lighting due to orientation; Left two: the balconies were used to store daily stuffs.

5.7 Discussion

Based on the above qualitative survey, it can be concluded that Case 2, as an award-winning project with high reputation, provided the most liveable residential environment among the four cases, benefiting from the mature neighbourhood, moderate development intensity, high-quality planning and community management, featured architecture design, and diversified luxury dwelling units; while Case 4, as the most recent development among the four cases, formed a significantly less liveable residential environment than the other cases due to the chaotic neighbourhood under regeneration, high development intensity, poor planning and community management, flawed architecture design, and economical dwelling units; As the earliest development among the four cases, Case 1 had a relatively low density with the highest proportion of dwelling units with north-south orientation and cross-ventilation, which provided comfortable indoor environment despite of the out-dated site planning and architecture design; Case 3, as a model commercial housing development with standardized plan and design, achieved a balance between development intensity and environment quality through the high-level landscape design and careful property management.

While the comparison of the overall performance of each case gives a general idea of the relative strengths and weaknesses of each development case, a case comparison based on the spatial levels further reveals the difference in performance of liveability elements in the study cases.

1. *Urban neighbourhood: the dilemma of high-intensity redevelopment*

As analysed in *Chapter 4*, the decay of the Chinese traditional and Soviet-style urban settlements, the shortage of urban housing, and the demands of urban development promoted the long-term and large-scale regeneration in the inner city of Tianjin since 2003. The neighbourhoods of the four cases are respectively in different degrees of completion of urban regeneration from mature (Case 2), semi-mature (Case 1), brand new (Case 3), to under regeneration (Case 4). A trend can be found that, ***the development intensities of the neighbourhoods of the four cases were lower for earlier developments and higher for more recent ones***. Based on the site investigations and interviews, it can be concluded that the high-intensity development in these areas indeed provided ***varied service facilities*** and ***convenient public transportation*** to a large number of population, while causing liveability issues including ***noise pollution***, ***traffic congestion***, ***poor tidiness*** and ***public security***.

Due to the on-going demolishment and redevelopment, the neighbourhood of Case 4 had a significantly poorer performance in terms of all 8 liveability elements than the other cases. The only discrepancy among Cases 1, 2 and 3 was on ***public spaces,*** with Cases 1 and 2 enjoying better urban public spaces being near an urban park with beautiful landscape and leisure spaces.

These findings revealed two importance liveability issues:

1) how to ensure the existing residents' quality of life during the long-term urban renewal;

2) how to create attractive public spaces in the high-intensity urban redevelopment.

Despite of the liveability problems, a ***strong neighbourhood attachment*** was celebrated in the high-rise inner-city housing estates according to most interviewees in this study. As was found by Hoang Huu Phe and Patrick Wakely (2000) and Marino Bonaiuto, et al.(1999, 2010), the trade-off elements such as the central location and convenient facilities could moderate the impact of the negative elements, and enforce the residents' sense of attachment to their neighbourhood, especially when the residents have made trade-offs before they purchased the properties.

2. *Housing estate: the importance of planning, landscape design and community management*

The four study cases were developed in the different stages of urban regeneration, and respectively reflected the different development strategies in each stage. As an early high-rise housing estate in the inner-city of Tianjin, Case 1 had the lowest development intensity, showing strong influence from the planning layout of the Soviet-style residential quarters: monotonous slab dwelling buildings with north-south orientation arranged in parallel in order to increase development intensity while ensuring environment quality.

With development intensity similar to that of Case 1, Case 2 was the outcome of a series of exploration and experimentation. In Case2, a new planning layout emerged, with: mixed various slab and short-slab dwelling buildings with north-south orientation in order to form a rich and comfortable community environment.

With significantly higher development intensity, Case 3 was a mature commercial housing product produced by one of the most prominent real estate developers in the country. It had a simple and effective planning layout: simplex short-slab dwelling buildings, with the same appearance and orientation, surrounding a large central garden with attractive landscapes in order to achieve a balance between development intensity and environment quality.

With the highest development intensity, Case 4 was the outcome of an increasingly profit-oriented planning strategy driven by the heated property market in recent years. It provided mixed short-slab and tower dwelling buildings with basically-designed economical units that were easy to sell due to the low prices. Consequently, the housing estate of Case 4 was significantly lower in all aspects of liveability elements.

From the perspective of development intensity, the four study cases can be divided into the low-intensity group (Case 1 and Case 2), and the high-intensity group (Case 3 and Case 4). Through comparison between them, it can be found that: ***the liveability of high-rise residential environment can be improved by high-quality planning, design and community management with*** appropriate ***internal traffic system,*** carefully-designed ***green area and landscape,*** comfortable ***outdoor environment and*** good ***sense of community.***

Some common problems are also identified in the high-density life of high-rise housing estates. These include: ***the lack of activity facilities*** for children and the elderly, and ***the shortage of internal service facilities*** including convenient stores, barber shops and restaurants. Moreover, ***wind environment*** was another major issue. To a large extent, these problems derived from the deficiency of the existing regulations and codes on urban high-rise housing design in coping with new practical requirements. Their improvement requires the modification of current provisions based on evidence provided by numerous empirical studies.

3. Dwelling building: the impact of building form and architecture design

As analysed in Chapter 4, building forms of high-rise housing are significantly related to the development intensity of housing estate and the indoor environment quality of dwelling units. The site investigations and interviews in the four cases confirmed the conclusion: with the increase of development intensity from slab, short-slab to tower high-rise housing, the environment quality indeed decreased.

Each case adopted the unified architecture design in order to save construction cost and establish their own community image. Within each case, however, the ***facade design*** of dwelling buildings was simplex and monotonous, which resulted in ***the poor identity*** within housing estate. Moreover, as showed in Case 3 and Case 4, although the standardized design could effectively reduce the cost, the design flaws and problems could cause substantial loss and damage. Therefore, the architecture design of large-scale high-rise housing estates should be carefully examined to minimize the possibility of serious problems.

The high-rise and high-density residential environment itself resulted in the concerns and dissatisfactions with ***security and safety***, which was consistent with the findings of Oscar Newman (1972, 1975) and Henry Shaftoe (2007). Although the gated community and the monitored entrances with CCTV and intercom system could improve the security situation, the great deal of semi-public spaces within high-rise dwelling buildings such as lift lobbies and corridors shared by many households could reduce the residents' sense of safety.

4. Dwelling unit: the balance between cost and quality

Based on the different development strategy and market positioning of the four cases, the proportions of the dwelling units with luxury size, layout, and comfort environment were varied, as well as the degree of luxury and comfort.

Among the four cases, as the earliest high-rise housing estate, Case 1 had the highest percentage of the comfort dwelling unit with moderate luxury degree; Case 2 provided the second highest proportion of dwelling units with high luxury degree; Case 3 achieved high luxury level, but the proportion of the dwelling units with north-south orientation and cross-ventilation was significantly lower than Case 1 and Case 2; Case 4 was the lowest in both aspects, which can be proved by the lowest property price and rental showed in Table 5-3.

Generally speaking, the new high-rise dwelling units provided much better residential environment than the existing old housing types, especially in the aspects of ***infrastructure***, ***natural lighting***, ***ventilation***, and ***heating***.

Among the 18 liveability elements, ***property cost*** and ***shortage of the auxiliary spaces*** including storage and balcony were the major common issues. On the one hand, the usage, maintenance and management of many public spaces and facilities including lifts, lighting, and water supply system inevitably led to the high property cost. On the other hand, with little previous experience, few high-rise residents were aware of the cost associated with high-rise living, which had been the main cause behind many conflicts between the property management companies and the residents. As a result, the expensive property service charge and the flawed property management exacerbated the residents' dissatisfaction. Moreover, the high construction and material cost of high-rise housing caused the auxiliary spaces to be compressed in order to control the total cost while ensuring the quality and quantity of the functional spaces such as living room, bedroom, and kitchen. As a result, many residents stored their stuff in balcony and bathroom, even in the public corridor, lobby and stair well, which caused some potential security and safety risks.

5.8 Conclusion

This chapter has achieved the second research objective:

> *To summarize the residential environment features of high-rise housing estates in China, investigate actual usage conditions and understand residents' liveability experience of the high-rise residential environment;*

Through an analysis of the planning and design documents, site investigations and interviews with the residents and the managers of the property management companies, the major features of the four study cases can be summarized:

Located in a semi-mature urban neighbourhood, **Case 1** is a housing estate with low development intensity, simplex planning and poor community management. It is dominated by slab high-rise dwelling buildings, and mainly comprised of economical dwelling units with comfortable indoor environment;

Located in a mature urban neighbourhood, **Case 2** is well managed and planned with moderate development intensity. It provides a rich and diversified built environment with mixed slab and short-slab high-rise dwelling buildings that consists of luxury dwelling units with diversified design;

Located in a brand new urban neighbourhood recently constructed in the inner-city urban regeneration, **Case 3** is a housing estate with high development intensity and good planning and community management. It is dominated by short-slab dwelling buildings with similar height and appearance, and comprised of luxury dwelling units with standardized design;

Located in a mixed-old and new urban neighbourhood under regeneration, **Case 4** is poorly planned and managed with very high development intensity. It comprises a mixture of short-slab and tower high-rise dwelling buildings with economical dwelling units with basic design.

Finally, the liveability evaluations of the four study cases have been preliminarily discussed from the overall residential environment, four spatial levels to 58 liveability elements. The following chapter will analyse in-depth the data of questionnaire survey in order to examine the conclusions and findings in this chapter, and explore the liveability strengths and weaknesses of high-rise housing estates in China.

Chapter six

Quantitative survey: residents' liveability evaluation of high-rise housing estates

6.1 Introduction

This chapter is focused on answering the Third research question:

> *'What are the residents' liveability evaluations of the high-rise residential environment in China, and what are the strengths and weaknesses of liveability of high-rise housing estates from the practical perspective?'*

Based on the data collected through the questionnaire survey, this chapter first summarizes the respondents' demographical features and residential environmental features, and examines the content reliability and internal consistency of the questionnaire. And then, the holistic liveability evaluations (the four study cases as a whole, N=214) are analysed in order to reveal the comprehensive liveability evaluation of high-rise housing estates in the inner city of Tianjin. Following this, the liveability evaluations of the four study cases are respectively analysed and compared so that the similarities and differences of their liveability evaluations can be explored. Integrating the above two results, the liveability strengths and weaknesses of high-rise housing estates can be summarized.

6.2 General information of the liveability survey

As explained in the methodology chapter (Chapter 3), the liveability survey consists of two stages: the first stage is a combination of questionnaires，preliminarily interviews with respondents at random sampling and out-door observation from the three environmental scales: dwelling building, housing estate and urban neighbourhood; the second stage is an in-depth interview with voluntary respondents and in-door investigation of their dwelling units and dwelling buildings. The detailed information of this survey is shown in Table 6-1.

Table 6- 1 Information of the Liveability Survey

Study Case	Sample Size	Total Number of Households	Sample Rate (%)	Number of Preliminarily Interview	Number 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: TianLin Garden	57	1861	3.1	14	3
Case 4: BaoLong Bay	57	1314	4.3	10	4
Total	214	6226	3.4	55	14

6.2.1 Content reliability and internal consistency of the questionnaire

Cronbach' alpha (α) is the most common measure to determine the internal reliability of the questionnaire. Based on the suggestion of Cronbach (1951), if the questionnaire has subscales, α should be applied separately to these subscales. Therefore, reliability analyses of 4 spatial levels have been respectively carried out. The generally accepted value is more than 0.8 (Field 2005). In this study, the results reflected a very good degree of reliability (Table 6-2). The Cronbach' alpha of the subscale of housing estate reached 0.911, which means excellent level of reliability. The lowest one was the subscale of urban neighbourhood with 0.860.

Table 6- 2 Reliability Tests of the 4 Subscales

Subscales	Number of Liveability elements	Cronbach' alpha values
Dwelling Unit	18	0.891
Dwelling Building	16	0.896
Housing Estate	16	0.911
Urban Neighbourhood	8	0.860

Moreover, the values of ***Alpha if Item Detected*** were calculated to test whether there were the liveability elements to negatively impact on the reliability. The outcomes indicated that only two elements: relationship with neighbours (from 0.897 to 0.896) and car/bike parking (from 0.913 to 0.911) very slightly decreased the overall reliability of their respective subscale. Altogether, the content reliability and internal consistency of the questionnaire achieved a high level from the perspective of statistics.

In order to examine the latent impact of different questioning approaches, the respondents were asked to answer two questions respectively at the beginning and the end of the questionnaire:

How would you evaluate your residential environment as a whole? (Evaluation)

Very Bad	Fairly Bad	Neither, Nor.	Fairly Good	Very Good
1	**2**	**3**	**4**	**5**

To what extent are you satisfied with your overall residential environment? (Satisfaction)

Very Dissatisfied	Fairly Dissatisfied	Neither, Nor.	Fairly Satisfied	Very Satisfied
1	**2**	**3**	**4**	**5**

Through Paired-Samples T-Test using SPSS to compare the answers of two questioning ways, the result indicated that the two questions yield a large correlation coefficient (*r = 0.640*) and are very significantly related (*p = 0.000*), and there is not a significant difference between the means of the two groups of answers because the two-tailed probability is relatively high (*p = 0.340*). It can be concluded that the two questioning ways do not significantly impact the outcomes of questionnaire survey from the perspective of statistics (Table 6-3).

Table 6- 3 Comparison of Means of Two Questioning ways (Paired-Samples T-Test)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Evaluation	3.76	214	.667	.046
	Satisfaction	3.72	214	.681	.047

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Evaluation & Satisfaction	214	.640	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair1	Evaluation - Satisfaction	.037	.572	.039	-.040	.114	.956	213	.340

6.2.2 Demographical features of the respondents

In this study, demographical characteristics consist of 6 indices: ***gender, age, level of education, family income, life stage*** and ***household size***.

1. Gender

Among the 214 respondents, the proportion of female (55.6%) was slightly high than male (44.4%). The gender distributions of the four study cases showed little difference (Figure 6-1).

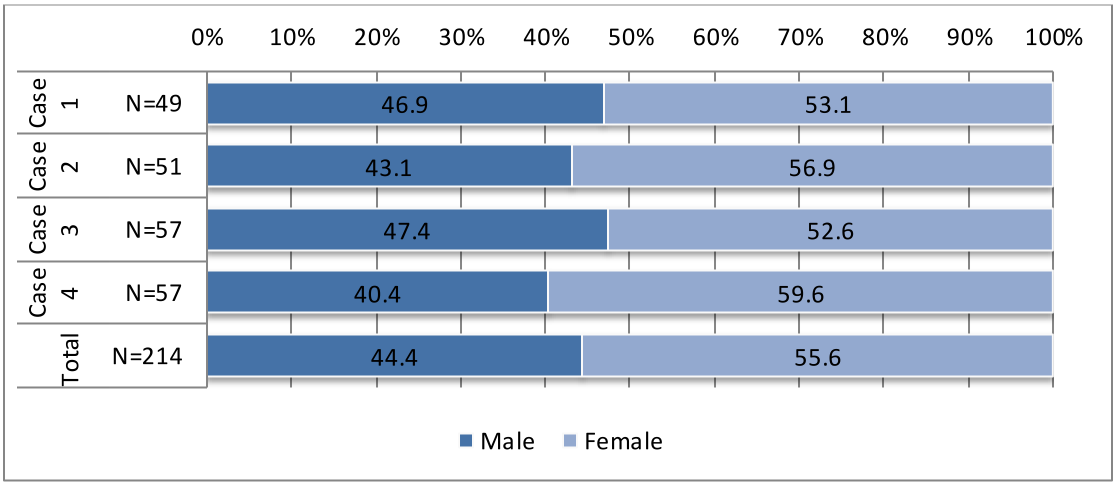


Figure 6- 1 Gender Distribution of the Respondents in the Four Study Cases

2. *Age*

The age composition was 37.9% of the elderly over 60, 33.2% of the middle-aged from 40 to 59, 28% of the young people between 18 and 39, and 0.9% of juvenile from 15 to 18. Among the 4 cases, the percentage of the young respondents in Case 3 (40.4%) was significantly higher than those of the other cases (Figure 6-2).

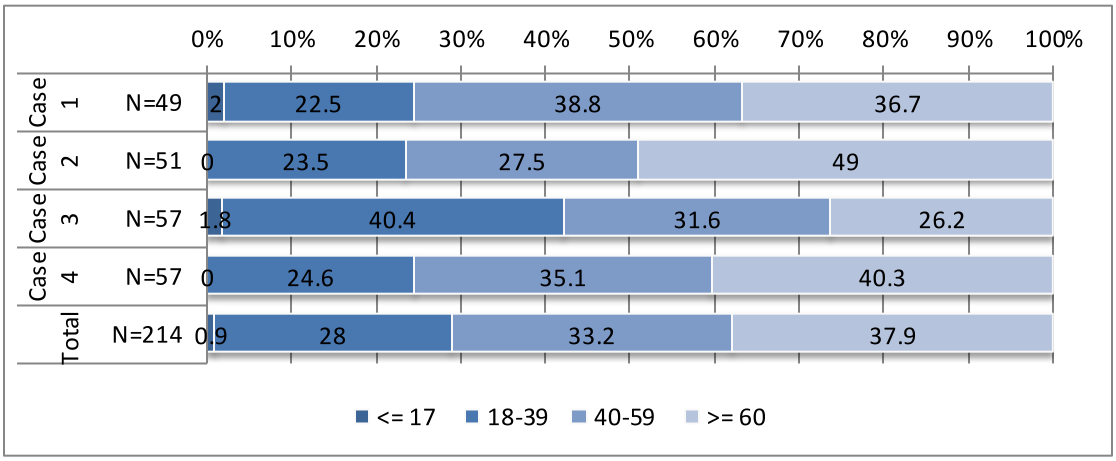


Figure 6- 2 Age Distribution of the Respondents in the Four Cases

3. *Level of education*

The majority of the respondents (55.6%) received university education, followed by the group with high school education (21.5%), and middle school education (16.4%). The percentage of the respondents with primary school and post-graduate education are both 3.3%. The average education level of the respondents in Case 2 and Case 3 were significantly higher than in Case 1 and Case 4 (Figure 6-3).

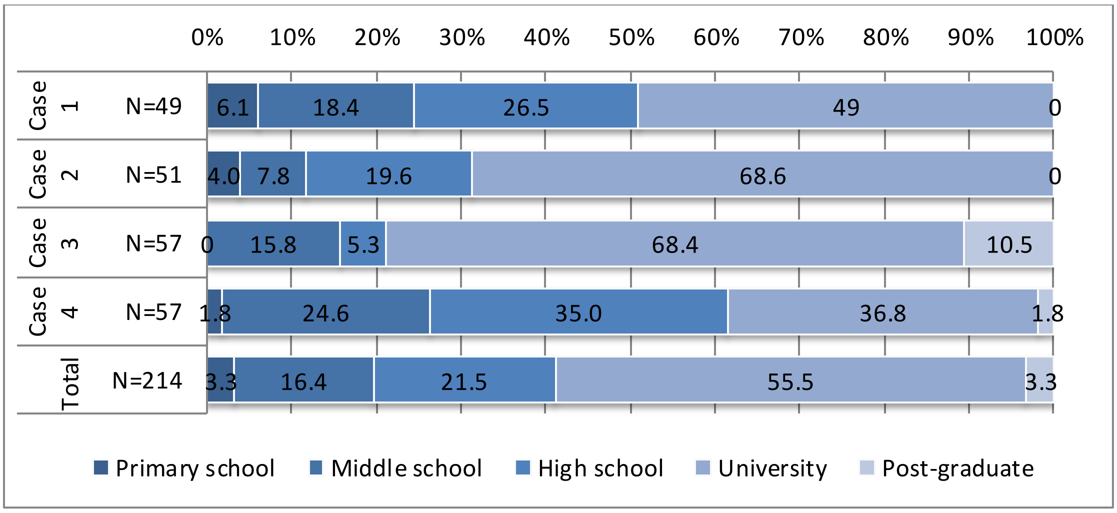


Figure 6- 3 Distribution of Education Level of the Respondents in the Four Cases

4. Family income

The monthly family income of 39.2% of respondents was between RMB5000 (GBP500) and RMB10000 (GBP 1000), followed by 35.1% whose earnings were less than RMB5000 (GBP500) and 25.7% earned more than RMB10000 (GBP 1000). Generally speaking, the average family income level of the respondents of Case 2 was the highest, while that of Case 4 was the lowest, with those of Case 1 and Case 3 in the middle (Figure 6-4).

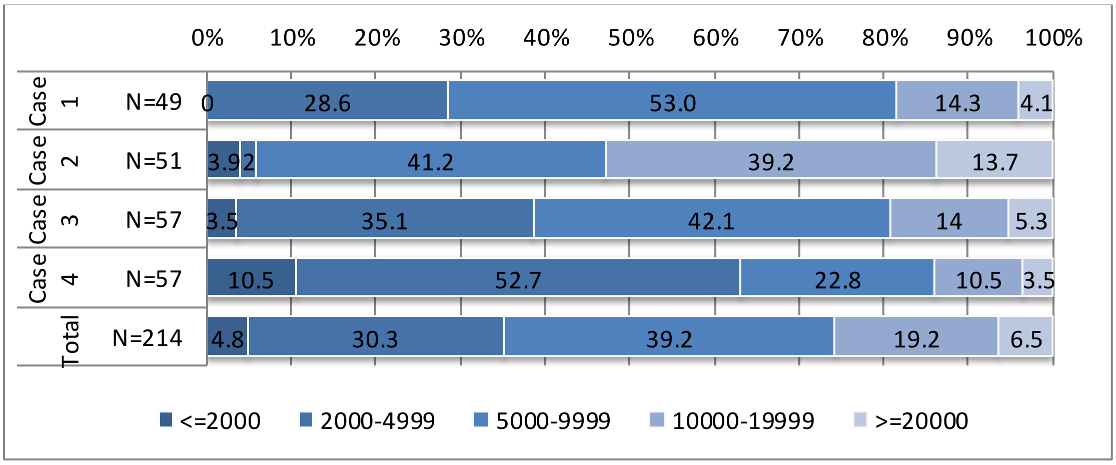


Figure 6- 4 Distribution of Family Income of the Respondents in the Four Cases

5. Household size

Core families with 3 or 4 members was the dominant household type in the study cases (55.6%), a large percentage of respondents (25.7%) were 2 person-households and 17.3% of the households were large families with over 5 people (Figure 6-5). Case 1 and Case 2 had higher proportions of respondents living in large families, while Case 3 and Case 4 had more respondents from small families.

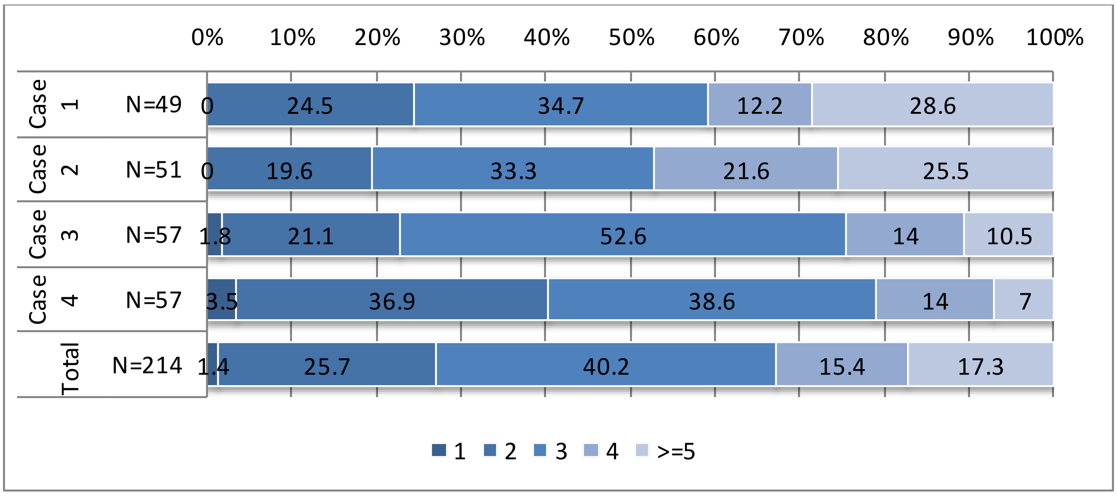


Figure 6- 5 Distribution of Household Size of the Respondents in the Four Cases

6. Life stage

In terms of life stage, about one quarter (15.9% + 9.8%) of the respondents were young couples with small children, which is different from some countries where the majority of the families with young children prefer to live in houses with garden. Moreover, 50.0% (9.8% + 23.4% + 16.8%) of the respondents were three-generation-households, which reflect the Chinese traditional residential culture discussed in *Section 4.4.1*. Meanwhile, it is worth noting that 21% of the respondents were elderlies living alone. Among the 4 cases, the percentage of the respondents with small children in Case 3 (40.4%) was significantly higher than those of the other cases (18.3%, 23.5% and 19.3%), and Case 2 had the highest percentage of three-generation households (47%). 31.6% of the respondents in Case 4 were elderlies living alone, which formed a characteristics different from the other cases (Figure 6-6).

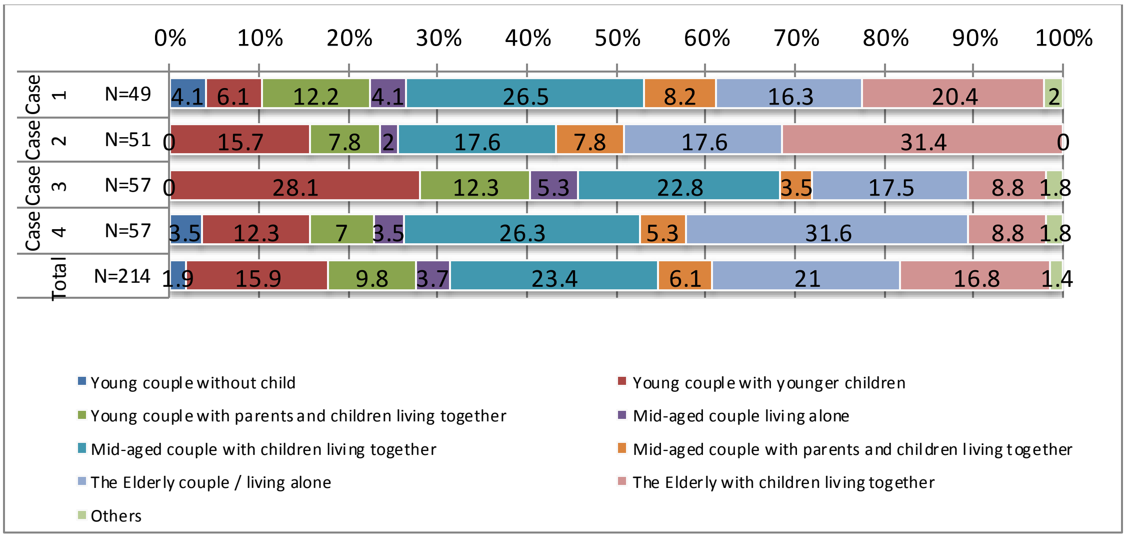


Figure 6- 6 Distribution of Life Stage of the Respondents in the Four Cases

6.2.3 Residential environmental features of the respondents

In the questionnaire survey, the residential environmental features of the respondents were collected in two dimensions: physical dimension and psycho-social dimension. The former includes 6 indices: dwelling unit's ***size***, ***storey***, ***orientation and ventilation***, dwelling building's ***layout***, ***building form*** *and* ***location in housing estate***. The later also consists of 6 indices: ***type of tenure, length of residence, history of high-rise living*** (whether or not formerly lived in high-rise housing), ***former housing type, preferred storey and preferred housing type***.

1. Size of dwelling unit

The data in Figure 6-7 indicated that the majority of respondents are living in 2-bedroom (59.8%) and 3-bedroom (33.7%) dwelling units. The proportion of the respondents living in larger flats with over 3 bedrooms in Case 2 (62.7%) was the highest, followed by Case 1 (38.8%), Case 3 (36.9) and Case 4 (8.8%).

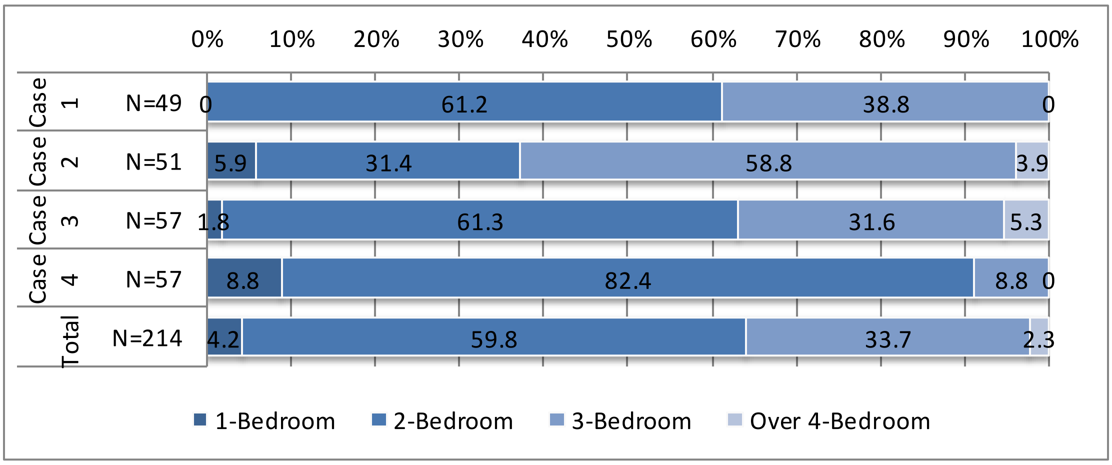


Figure 6-7 Size Distribution of Dwelling Units of the Respondents in the Four Cases

Table 6-4 presents a comparison made between the sampled distribution of household sizes in the study cases with their actual population distribution data calculated from the planning and design archives in Tianjin (see Table 5-2). It is shown that the sample distribution is consistent with the actual population distribution.

Table 6-4 Comparison between Sampled Distributions of Household Sizes of the Study Cases with their Actual Population Distribution

Size	Case 1 (N=49)		Case 2 (N=51)		Case 3 (N=57)		Case 4 (N=57)	
	Population	Sample	Population	Sample	Population	Sample	Population	Sample
One-bedroom	4.2	0	7.3	5.9	12.8	1.8	18.3	8.8
Two-bedroom	55.6	61.2	39.5	31.4	56.1	61.4	62.6	82.4
Three-bedroom	40.2	38.8	47.2	58.8	24.1	31.6	19.1	8.8
4-bedroom	0	0	6	3.9	7.0	5.3	0	0

2. Storey of dwelling unit

The percentages of the respondents who live on different floors are shown in Figure 6-8. The different distributions reflected the different combinations of building form and building height in the 4 cases (Table 6-5).

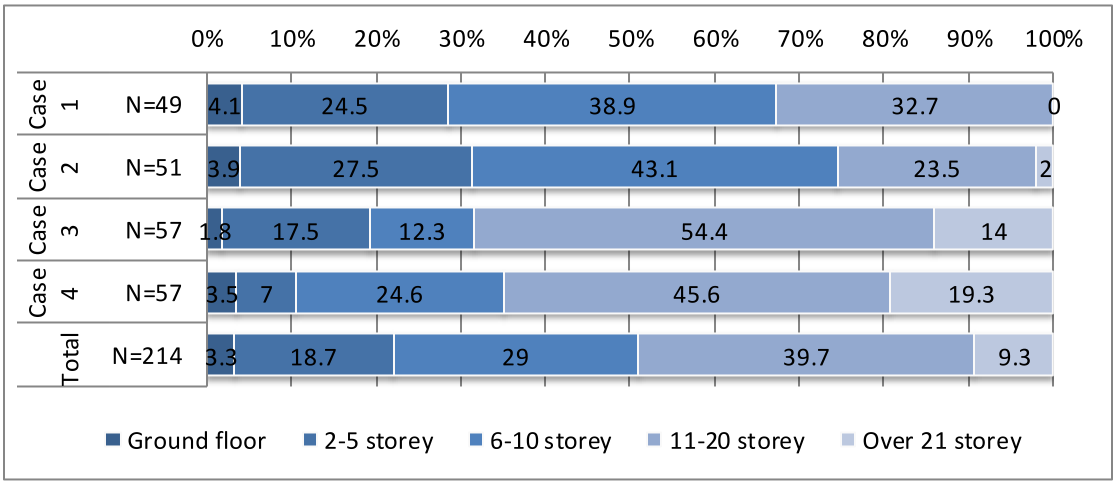


Figure 6-8 Floor Distribution of Dwelling Units of the Respondents in the Four Cases

Table 6-5 Combination of Building Form and Height in the Four Cases

Building form	Case 1	Case 2	Case 3	Case 4
Slab high-rise dwelling buildings	Two 9-story buildings; Two 10-story buildings; Two 11-story buildings; 4 12-story buildings; Two 13-story buildings.	4teen 9-story buildings; One 18-story building; One 24-story building;	None	None
Short-slab high-rise dwelling buildings	Three 18-storey buildings;	Seventeen 18-story buildings;	Eight 27-story buildings; Ten 28-story buildings;	Six 18-story buildings; Three 26-story buildings; Two 28-story buildings; Two 32-story buildings;
Tower high-rise dwelling building	None	None	None	Two 32-story tower high-rises

3. Orientation and ventilation of dwelling unit

A large percentage of the respondents (65.9%) were living in south-north-orientated dwelling units with cross-ventilation, followed by 26.6% living in south-oriented dwelling units without cross-ventilation, and 7.5% whose dwelling units were corner-location without cross-ventilation. Among the 4 cases, the majority of dwelling units of the respondents in Case 1 (91.8%) and Case 2 (92.2%) had both good orientation and natural ventilation, 59.6% in Case 3 did not have good natural ventilation, and 29.1% in Case 4 had both poor orientation and poor ventilation (Figure 6-9).

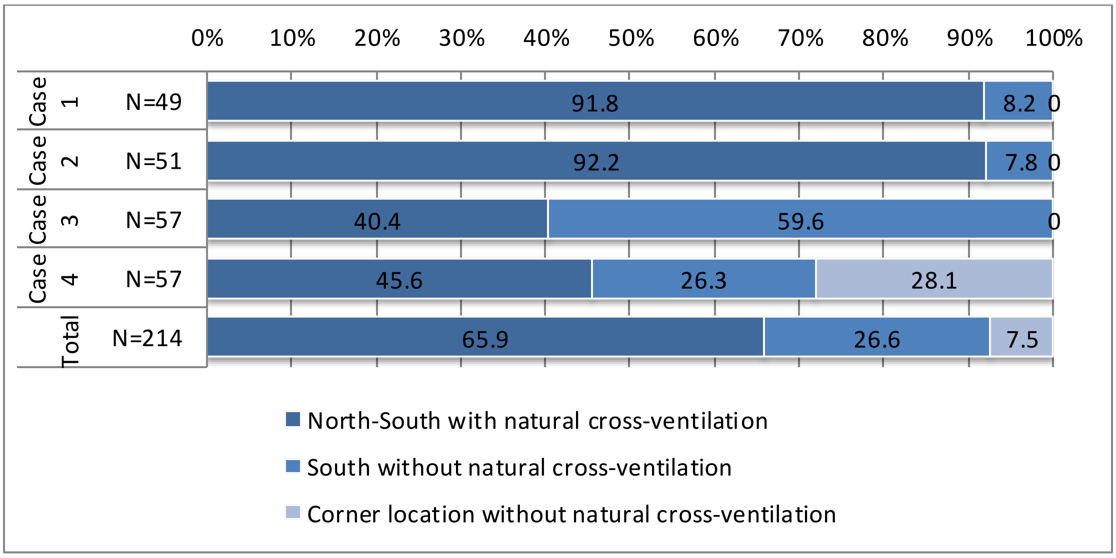


Figure 6- 9 Distribution of the Respondets Living in Dwelling Units with Different Orientation and Ventilation

Table 6-6 Comparison between Sampled Dwelling Units and the Actual Population Distribution of Dwelling Units with Different Orientation and Ventilation

Orientation and ventilation	Case 1 (N=49)		Case 2 (N=51)		Case 3 (N=57)		Case 4 (N=57)	
	Population	Sample	Population	Sample	Population	Sample	Population	Sample
North-South with natural cross-ventilation	93.2	91.8	74.5	92.2	60.6	40.4	50.6	45.6
South without natural cross-ventilation	6.8	8.2	25.5	7.8	39.4	59.6	25.1	26.3
Corner location without natural cross-ventilation	0	0	0	0	0	0	24.3	28.1

A comparison of the distribution of dwelling units with different orientation and ventilation in the 4 cases between the survey sample and actual population was carried out, and the results in Table 6-6 indicated the validity of the random sampling survey.

4. Building form of dwelling building

At the spatial level of dwelling building, as Figure 6-10 showed, 54.6% of the respondents were living in short-slab high-rise buildings, while 37.9% were living in slab high-rise buildings and 7.5% living in tower high-rise buildings. The sample distributions of building forms in the four study cases were compared with the actual distributions in Table 6-7, and the outcomes revealed the relatively high consistency between sample and actual population.

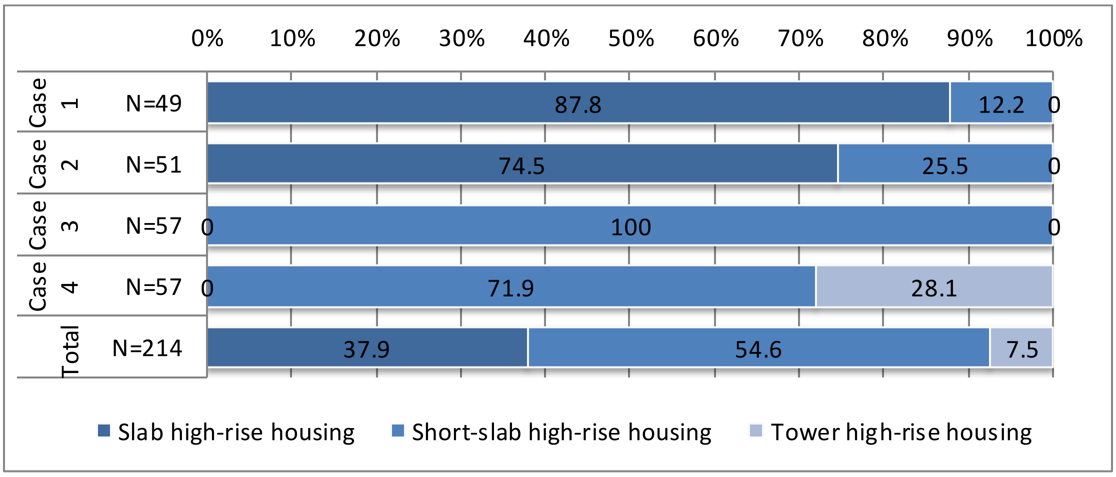


Figure 6- 10 Distribution of the Respondents Living in Different Building Forms

Table 6- 7 Comparison between Sampled Dwelling Units and the Actual Population Distribution of Dwelling Units Located in Different Building Forms

Dwelling units located in different building forms	Case 1 (N=49)		Case 2 (N=51)		Case 3 (N=57)		Case 4 (N=57)	
	Population	Sample	Population	Sample	Population	Sample	Population	Sample
Slab high-rise dwelling buildings	85.3	87.8	55.2	74.5	0	0	0	0
Short-slab high-rise dwelling buildings	14.7	12.2	44.8	25.5	100	100	75.7	71.9
Tower high-rise dwelling building	0	0	0	0	0	0	24.3	28.1

5. *Layout of dwelling building*

In high-rise residential buildings, communal services such as the elevators and communal spaces are shared among residents in the same dwelling building. Therefore, the number of dwelling units sharing one elevator is a good indication of household density.

Because the vertical transport of high-rise housing mainly relies on elevator, the number of elevators and the number of dwelling units that share the elevators beaome the key element that can indicate the layout and household density of dwelling buildings. The dominant layout forms are 1-lift-2-dwelling-unit per floor (33.2%) and 2-lift-3-dwelling-unit per floor (39.3%), and the tower high-rise housing adopted the layout of 3-lift-6-dwelling-unit per floor (7.5%). Obviously, the proportion of low density layouts with two dwelling units per floor in Case 1 (79.6%) and Case 2 (62.7) were significantly higher than those of Case 3 (26.3%) and Case 4 (0%). Case 4 adopted the layouts with more dwelling units per floor than the other three cases.

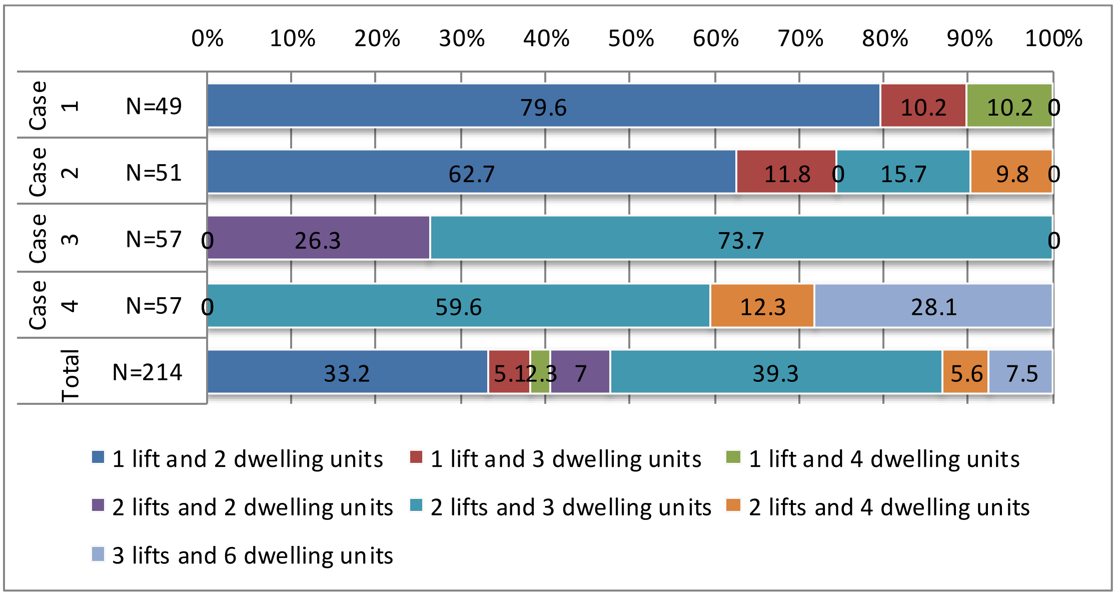


Figure 6- 11 Distribution of the Respondents Living in Dwelling Buildings with Different Layouts

6. Location of dwelling building in the housing estate

In addition, the respondents whose dwelling buildings were located near the boundaries of the housing estate accounted for 57%, and 43% were located in the middle of the community (Figure 6-12). Due to the different planned layouts of the 4 cases, the percentage of the respondents living in the middle of the gated community in Case 4 (15.8%) was significantly lower than those of the other cases.

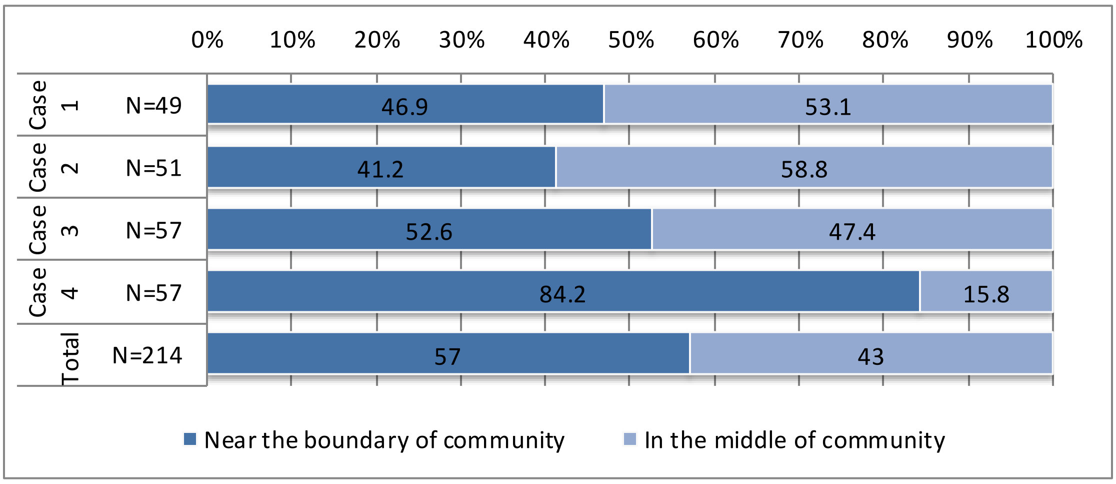


Figure 6- 12 Distribution of the Respondents Living in Dwelling Buildings with Different Location

7. Type of tenure

The data showed that the majority of the respondents (93.9%) were owner-occupiers, and there were no significant difference between the 4 cases (Figure 6-13). The high proportion of owner-occupied households in Tianjin formed the characteristics that differed from cities in developed countries (Roeloffzen, Lanting et al. 2004, Turkington, Kempen et al. 2004). The situation was the outcome of both the governments' promotion to encourage housing ownership and the impact of Chinese traditional housing culture that valued the ownership of dwelling (Dai 2008).

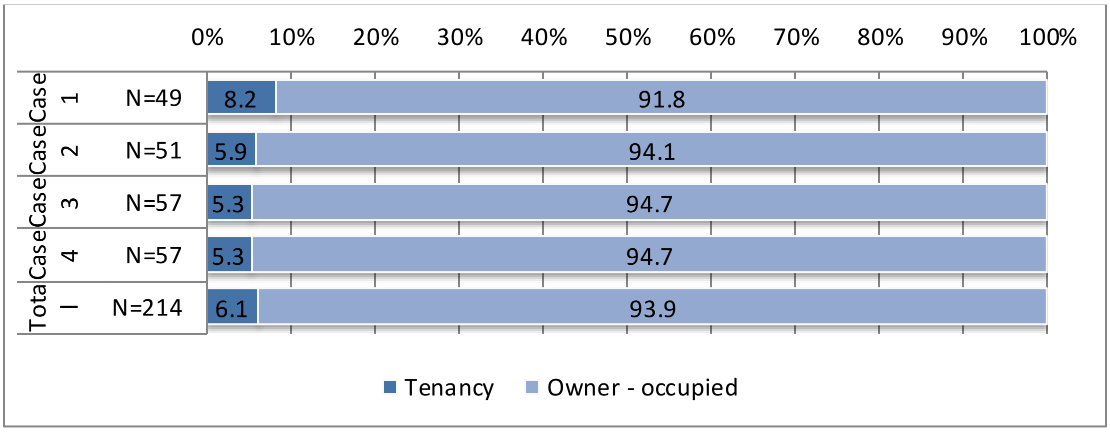


Figure 6- 13 Distribution of the Respondents Living in Dwelling Units of Different Tenure Types

8. Length of residency

As Figure 6-14 showed, over half of the respondents (53.7%) have been living in the current housing estates for 2 to 3 years, 32.7% had been here for 4 to 5 years and 8.9% had lived here for 6 to 7 years. Among the 4 cases, the distributions of residency length of the respondents were significantly different because of the different completion time of the study cases: September 2005 (Case 1), April 2007 (Case 2), October 2008 (Case 3) and November 2008 (Case 4).

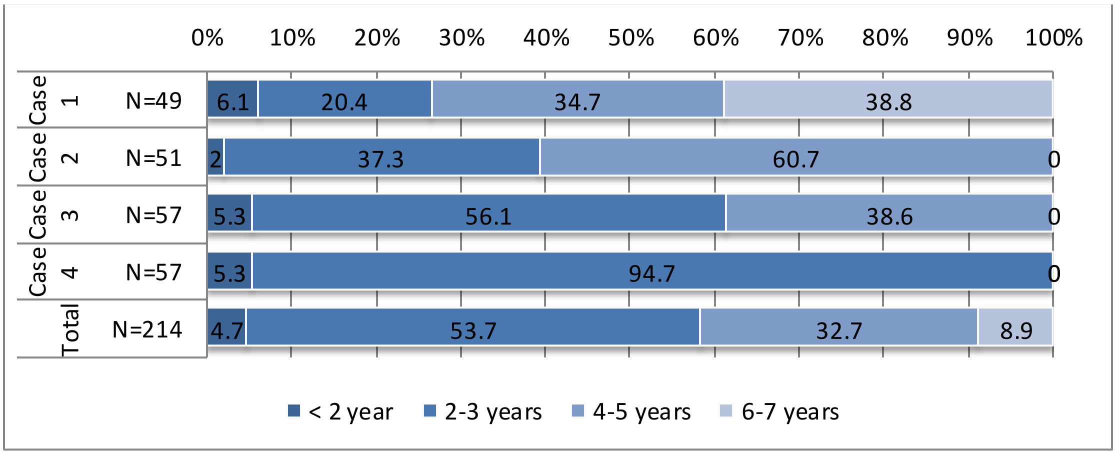


Figure 6- 14 Distribution of the Respondents' Length of Residence

9. History of high-rise living

Only 22.4% of the respondents have experiences of high-rise living before they moved into their current high-rise housing. The percentage of the respondents with high-rise living experience in Case 1 (12.2%) was the lowest, and that of Case 3 (31.6%) was the highest among the 4 cases (Figure 6-15).

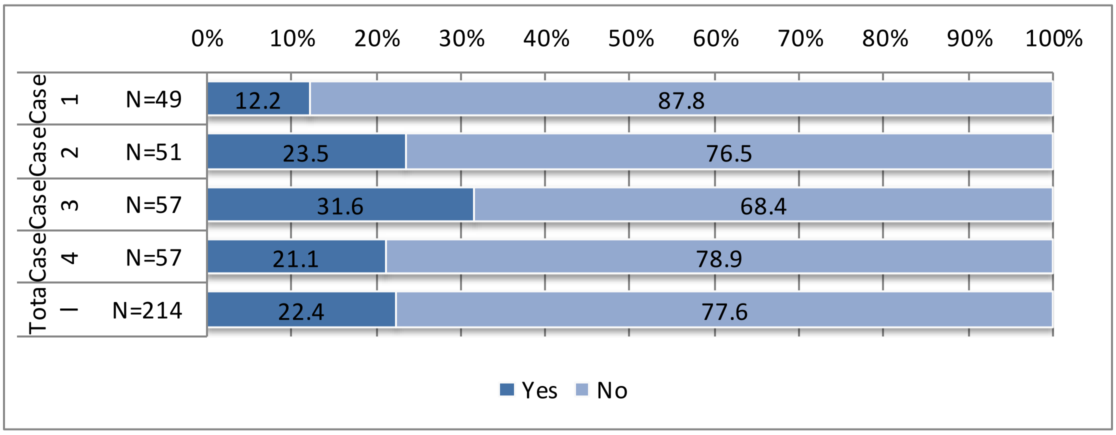


Figure 6- 15 Proportion of the Respondents with and without High-rise Living Experience

10. Former housing type

56.5% of the respondents had lived in multi-storey housing (under 6 storeys) before they moved to their present homes; and respectively 15.4% and 4.7% had lived in courtyard houses and low-rise terrace houses before becoming high-rise residents (Figure 6-16). Comparatively speaking, the proportion of the respondents who had lived in courtyard houses in Case 4 (31.6%) was the largest, and followed by Case 1 (16.3%), Case 3 (10.5%), and Case 2 (5.9%).

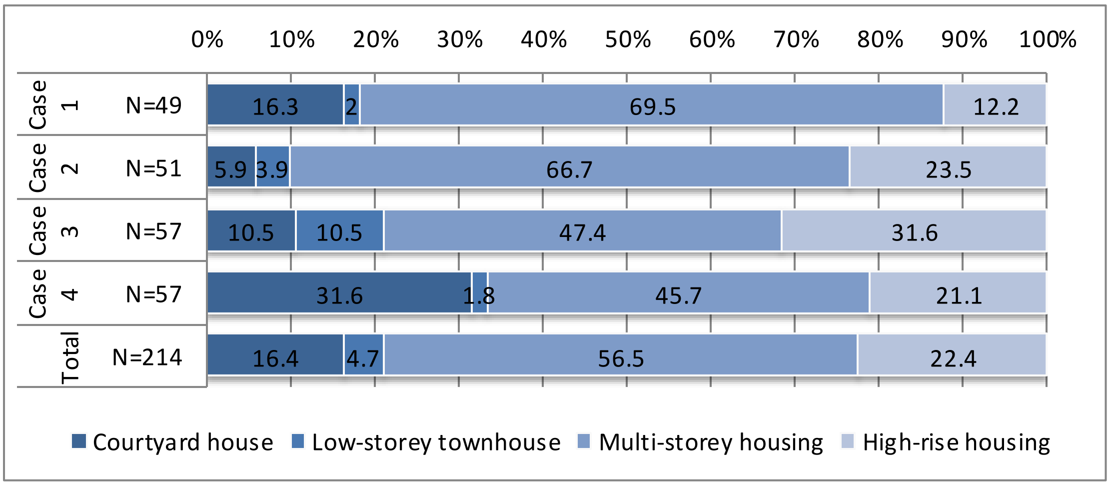


Figure 6- 16 Distribution of the Respondents with Different Former Housing Types

11. Preferred floor

In terms of the storey the respondent prefers to live on, the 7th to 10th storey (26.6%) was the most popular choice, followed by the 11th to 15th storey (23.8%), the 2nd to 6th storey (21%) and the 16th to 20th storey (12.6). 7% of the respondents preferred to live on ground floor and over 21 storeys, and only 1.4% liked the top floor. Over 80% of the respondents in three study cases (Cases 1, 2 and 4) preferred floors below the 15th storey, while in Case 3, the percentage is lower at 63.1% (Figure 6-17).

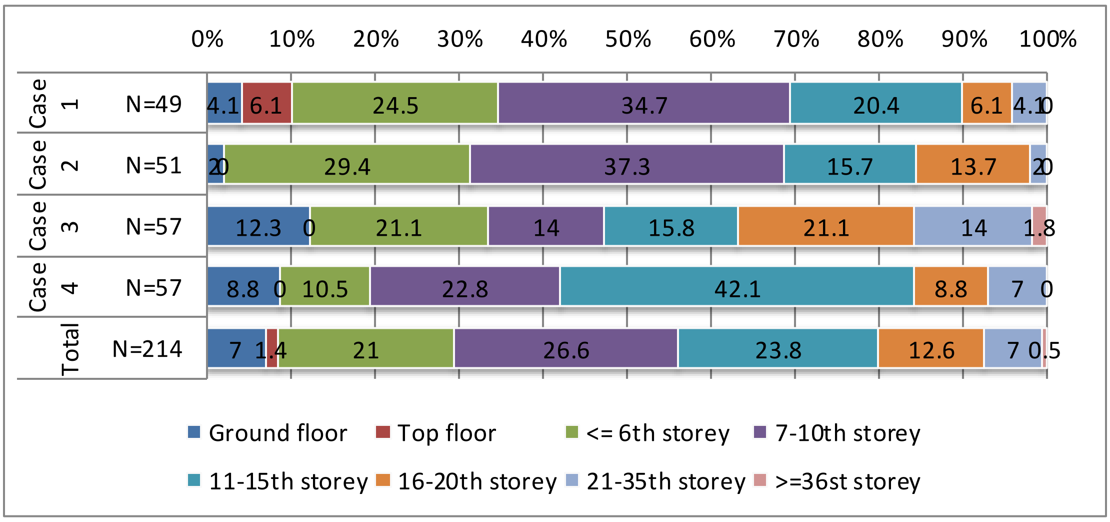


Figure 6- 17 Distribution of the Respondents Preferred Different Floors of High-rise Housing

12. Preferred housing type

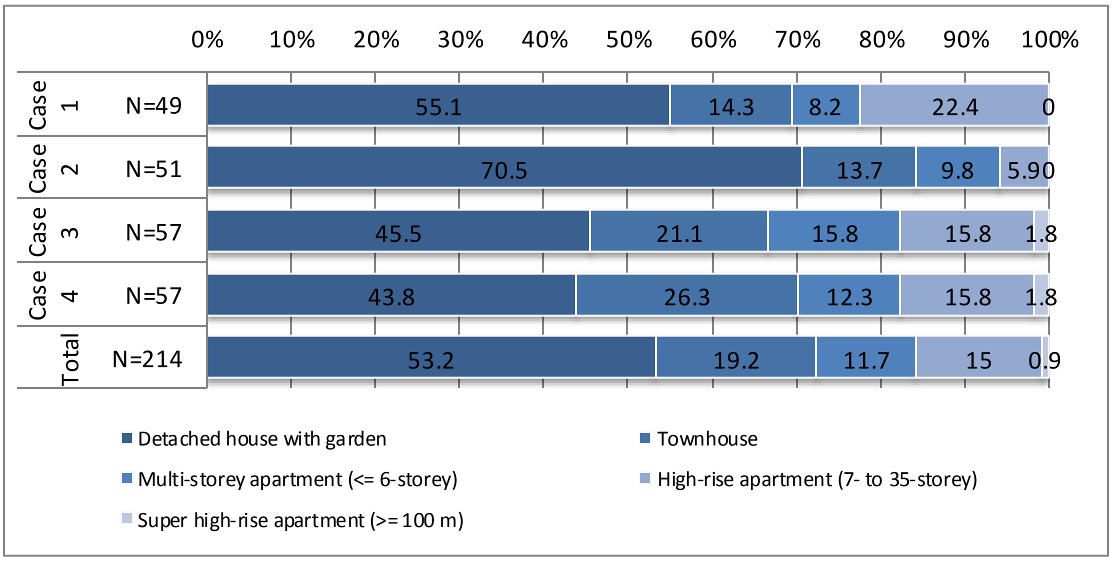


Figure 6- 18 Distribution of the Respondents Preferred Different Floors of High-rise Housing

In terms of their ideal housing type, 72.4% of the respondents expressed preference to live in low-rise family houses, while only 15.9% still preferred living in high-rise housing. More respondents in Case 2 (70.5%) preferred detached house with garden than those in Case 1 (55.1%), Case 3 (45.5%) and Case 4 (43.8%). Obviously, the detached garden house was the most favourable housing type of inner-city residents in Tianjin.

6.3 Holistic liveability evaluation of high-rise housing estates

In this section, the data analysis focused on the holistic liveability evaluation of the four study cases as a whole in order to explore the common problems of high-rise housing estates in the context of the inner city of Tianjin.

As explained earlier in Chapter 3, the liveability evaluation consists of three hierarchical layers: the overall residential environment, the four spatial levels, and 58 liveability elements (Table 6-8). The following sections will focus on the analyses the survey data from these three levels.

Table 6- 8 the Hierarchical Structure of Liveability Evaluation

		Overall Residential Environment of High-rise housing estates			
Four Spatial Levels		**Dwelling Unit**	**Dwelling Building**	**Housing Estate**	**Urban Neighbourhood**
58 Liveability Elements	Physical Dimension	Size, Layout, Storage, Structure quality, Infrastructure, Natural lighting, Natural ventilation, Heating in winter, Cooling in Summer, Indoor Air Quality, Internal Sound-proof, External Sound-proof, Private Outdoor Space, View from Windows,	Building Form, Building Height, Façade Design, Construction Quality, Quality and Quantity of Lifts, Communal Space, Public Lighting, Ventilation of Public Space, Barrier-free Design, Household Density, Upkeep of Public Facilities, Collection of Domestic Waste.	Green Area and Landscape, Play Areas for Children, Activity Places for the Elderly, Pedestrian Walkways, Internal Motor Roads, Car/Bike Parking, Internal Public Service Facilities, Barrier-free Design, Building Density and Spacing, Outdoor Environment in Summer, Outdoor Environment in Winter, Wind Environment,	Local Public Spaces, Local Service Facilities, Noise, Traffic Situation, Public Transportation, Environmental Tidiness,
	Psycho-social Dimension	Privacy, Safety, Comfort, Property Cost.	Fire and Seismic Safety, Security in Building, Identity of Building, Relationship with Neighbours	Population Density, Maintenance and Management, Community Security, Sense of Community.	Public Security Situation, Neighbourhood Attachment.

6.3.1 Evaluation and satisfaction of overall residential environment of high-rise housing estates

The mean values of evaluation and satisfaction with overall residential environment respectively were 3.76 and 3.72 on a five-point scale. The positive evaluation of the overall residential environment was 68.2% that included 10.3% of 'very good' and 57.9% of 'fairly good', neutral evaluations accounted for 29.9%, and negative evaluations accounted for only 2.9% (Figure 6-19). Meanwhile, the satisfaction rate with the overall residential environment was 69.6%, in which 6.5% indicated 'very satisfied' and 63.1% were 'fairly satisfied'. The dissatisfaction rate was also low at 3.73% with the rest giving neutral opinions.

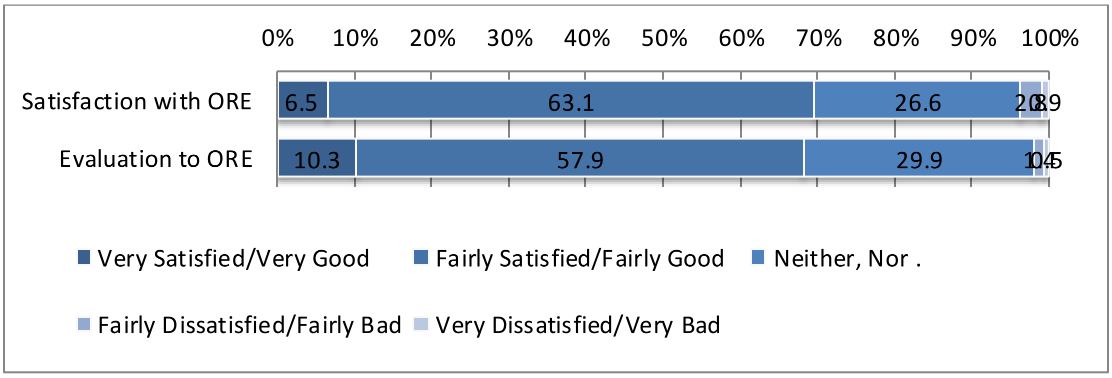


Figure 6- 19 Evaluation and Satisfaction Rate with Overall Residential Environment (ORE) of High-rise housing estates

6.3.2 Satisfaction with the four spatial levels of high-rise housing estates

In terms of the four spatial levels, a trend can be identified that the levels of satisfaction decreased with the expansion of the spatial levels from dwelling unit (3.73), dwelling building (3.68), housing estate (3.64) to urban neighbourhood (3.55) (Table 6-9).

Table 6-9 Satisfaction Levels of Overall Residential Environment and four spatial levels

Satisfaction with	Mean	N	Std. Deviation	Std. Error Mean
Overall Residential Environment	**3.72**	**214**	**.681**	**0.046**
Urban Neighbourhood	3.55	214	.616	0.042
Housing Estate	3.64	214	.616	0.042
Dwelling Building	3.68	214	.541	0.036
Dwelling Unit	3.73	214	.556	0.037

In terms of satisfaction rate, because the percentages of both 'very satisfied' and 'very dissatisfied' of the majority of factors were lower than 10%, thus they were respectively combined with 'fairly satisfied' and 'fairly dissatisfied' into 'positive evaluation' and 'negative evaluation' in order to clearly indicate the satisfaction rate and the dissatisfaction rate.

As Figure 6-20 indicated, the satisfaction rate of dwelling unit (71.5%) was the highest followed by that of dwelling building (68.2%), housing estate (65.4%) and urban neighbourhood (55.6%). The trend that the satisfaction rate increased with the contraction of the spatial scales from urban neighbourhood to dwelling unit manifested initially.

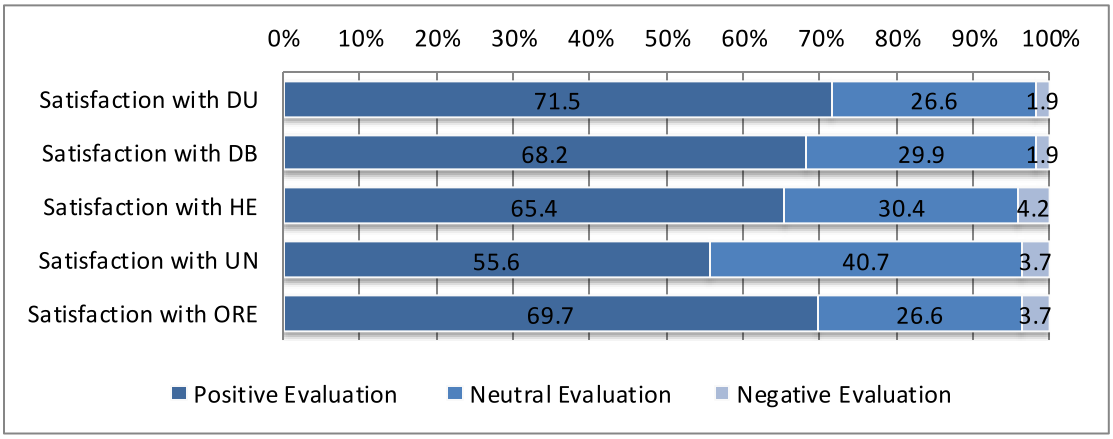


Figure 6- 20 Satisfaction Rates of Overall Residential Environment (ORE) and four spatial levels: Urban Neighbourhood (UN), Housing Estate (HE), Dwelling Building (DB), and Dwelling Unit (DU)

6.3.3 Satisfaction with the 58 liveability elements

The 58 liveability elements were grouped according to the four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit.

1. Urban neighbourhood

At the spatial level of urban neighbourhood, 8 liveability elements have been evaluated (Figure 6-21). Although all of the elements obtained satisfaction levels higher than the median 3, there are five elements including *noise* (3.12), *local public spaces* (3.36), *environmental tidiness* (3.37), *traffic conditions* (3.43) and *public security conditions* (3.48) whose satisfactions were at the relatively low interval between 3.0 and 3.5, three elements: *public transportation* (3.66), *local service facilities* (3.65) and *neighbourhood attachment* (3.59) were at the interval between 3.5 and 4.0.

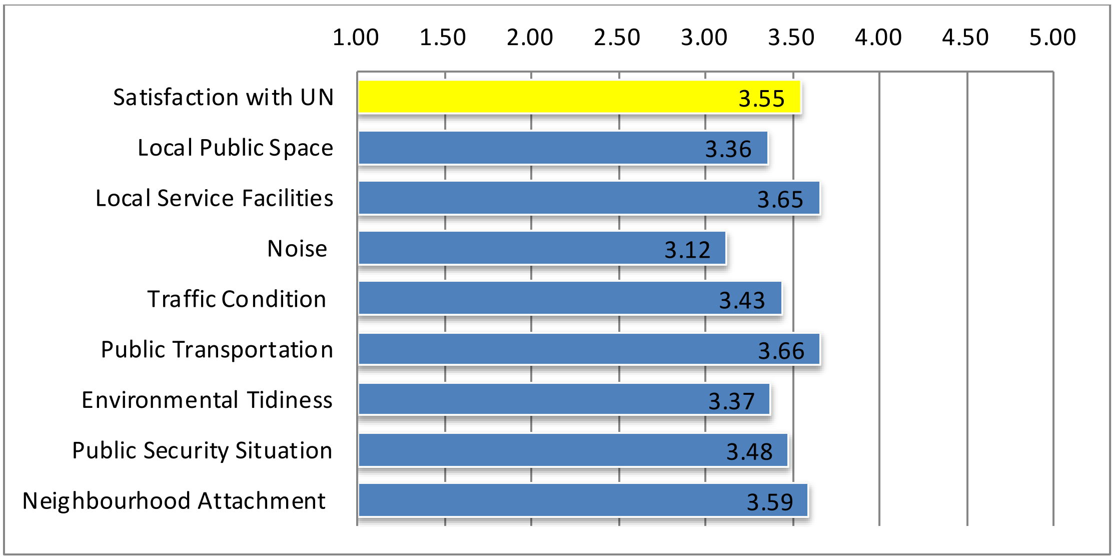


Figure 6- 21 Satisfaction Levels with Urban Neighbourhood (UN) and its 8 Liveability Elements

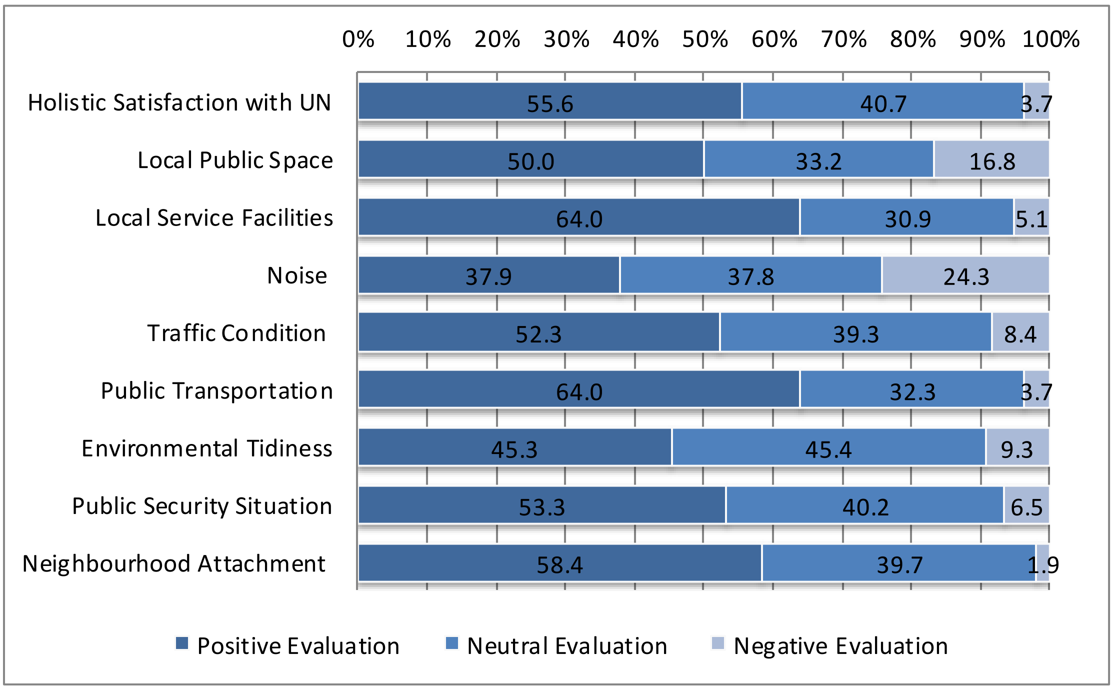


Figure 6- 22 Satisfaction Rate with Urban Neighbourhood (UN) and its 8 Liveability Elements

Among all liveability elements at this spatial level, only *noise* (37.9%) and *environmental tidiness* (45.3%) were lower than 50% (Figure 6-22). The dissatisfaction rate of *noise* (24.3%) and *local public spaces* (16.8%) were significantly higher than those of the other elements. The elements receiving the highest satisfaction rates were *local service facilities* (64.0%) and *public transportation* (64.0%).As the inner-city neighbourhoods are being regenerated, urban infrastructures have been updated to a higher standard. With their central location where main transportation hubs concentrate, inner-city neighbourhoods have gained much advantage for residential option despite the disadvantages accompanying rapidly increasing density, such as noise and environmental degradation.

2. Housing estate

At the spatial level of housing estate, 16 liveability elements were evaluated (Figure 6-23). The respondents' level of satisfaction with *activity places for the elderly* (3.05) was the lowest, while the satisfaction level of *outdoor environment in summer* (3.69) was the highest.

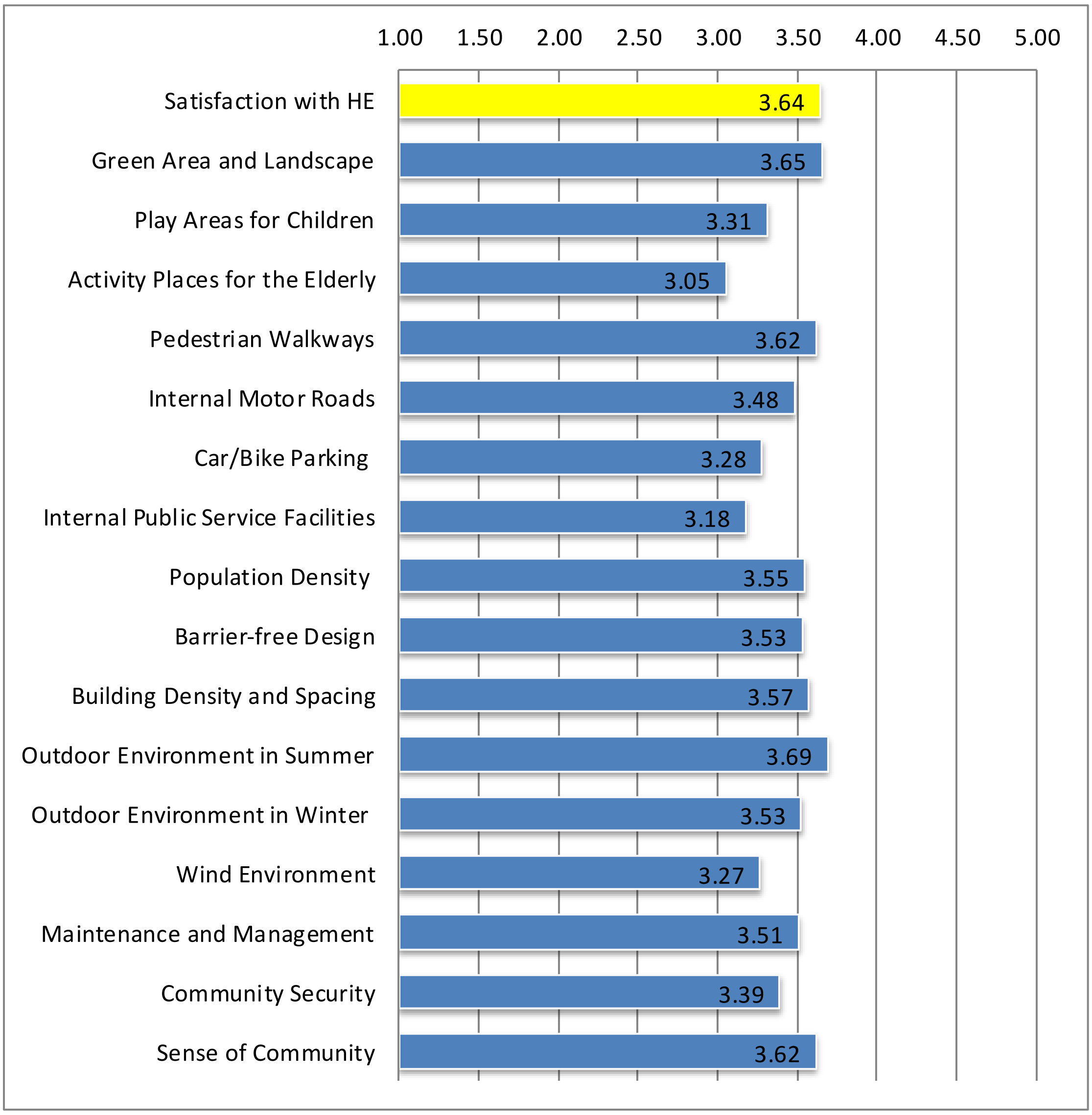


Figure 6- 23 Satisfaction Levels with Housing Estate (HE) and its 16 Liveability Elements

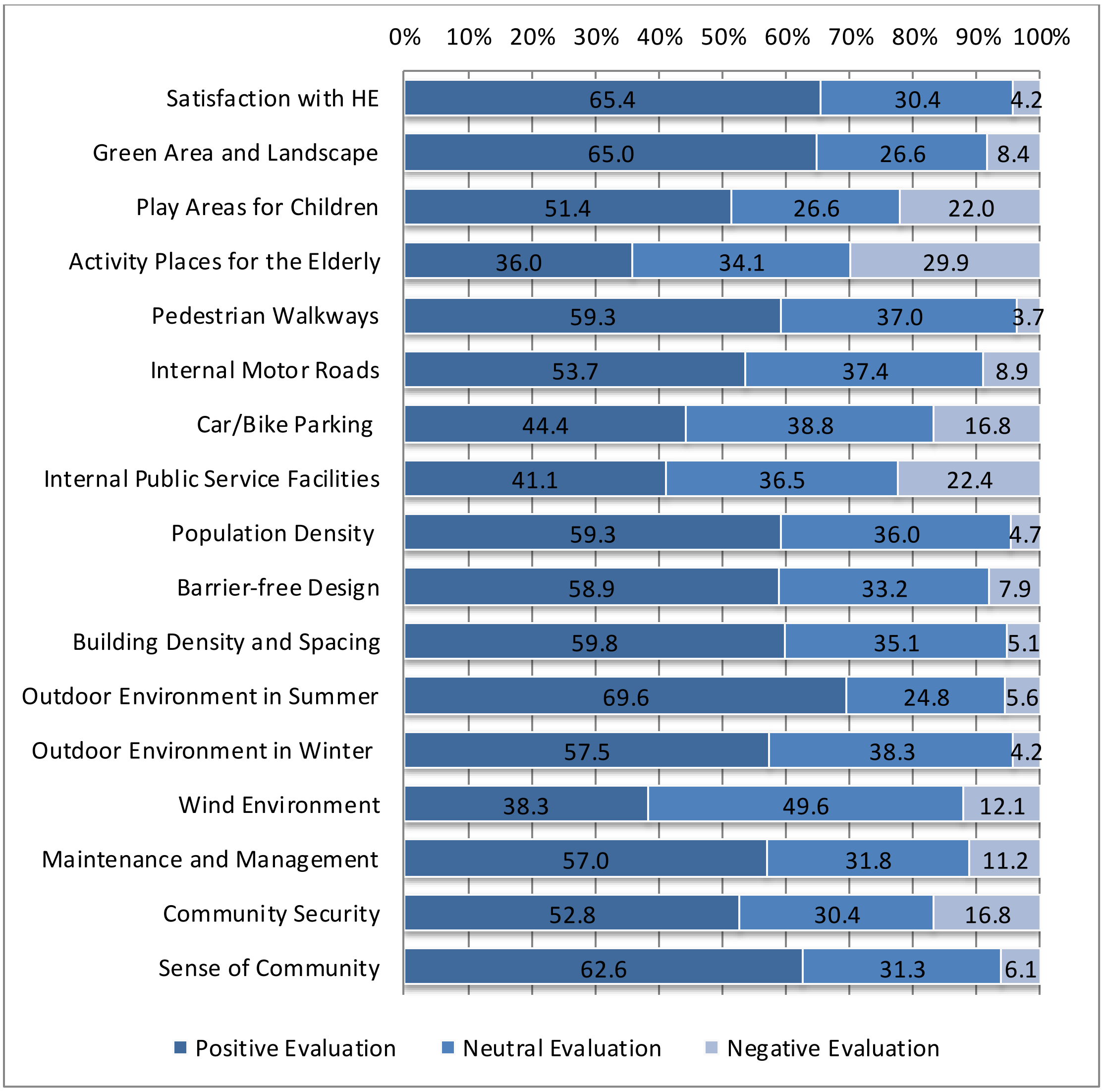


Figure 6- 24 Satisfaction Rate with Housing Estate (HE) and its 16 Liveability Elements

As Figure 6-24 showed, the satisfaction rate of *activity places for the elderly* is the lowest (36%), followed by *wind environment* (38.3%), *internal public service facilities* (41.1%) and *car parking* (44.4%). The percentage of respondents with negative evaluation is the largest in *activity places for the elderly* (29.9%), followed by *internal public service facilities* (22.4%), and *play area for children* (22%). On the contrary, 69.6% of respondents were satisfied with the summer outdoor environment of their housing estates. Given the climate of Tianjin, the high-rise buildings can bring more breezes and produce larger shadows on the ground, which could improve the comfort of the outdoor environment in summer while impairing it in winter. Benefiting from the regulations on the insolation interval between tall buildings, larger and more centralized spaces can be used as *green areas and landscape*, which contributed to the high satisfaction rate (65%). Public service facilities such as convenience stores and barber's shops, and activity spaces for both the elderlies and young children are considered inadequate according to the survey data.

3. Dwelling building

At the spatial level of dwelling building, *identity of building* (3.36) obtained the lowest satisfaction level among the 16 liveability elements. Moreover, *security in building* (3.44) and *construction quality* (3.48) have both been given relatively low ratings of below 3.5, which show consistency with findings in the research on high-rise housing of Henry Shaftoe (2007) in UK and Oscar Newman (1972) in USA.

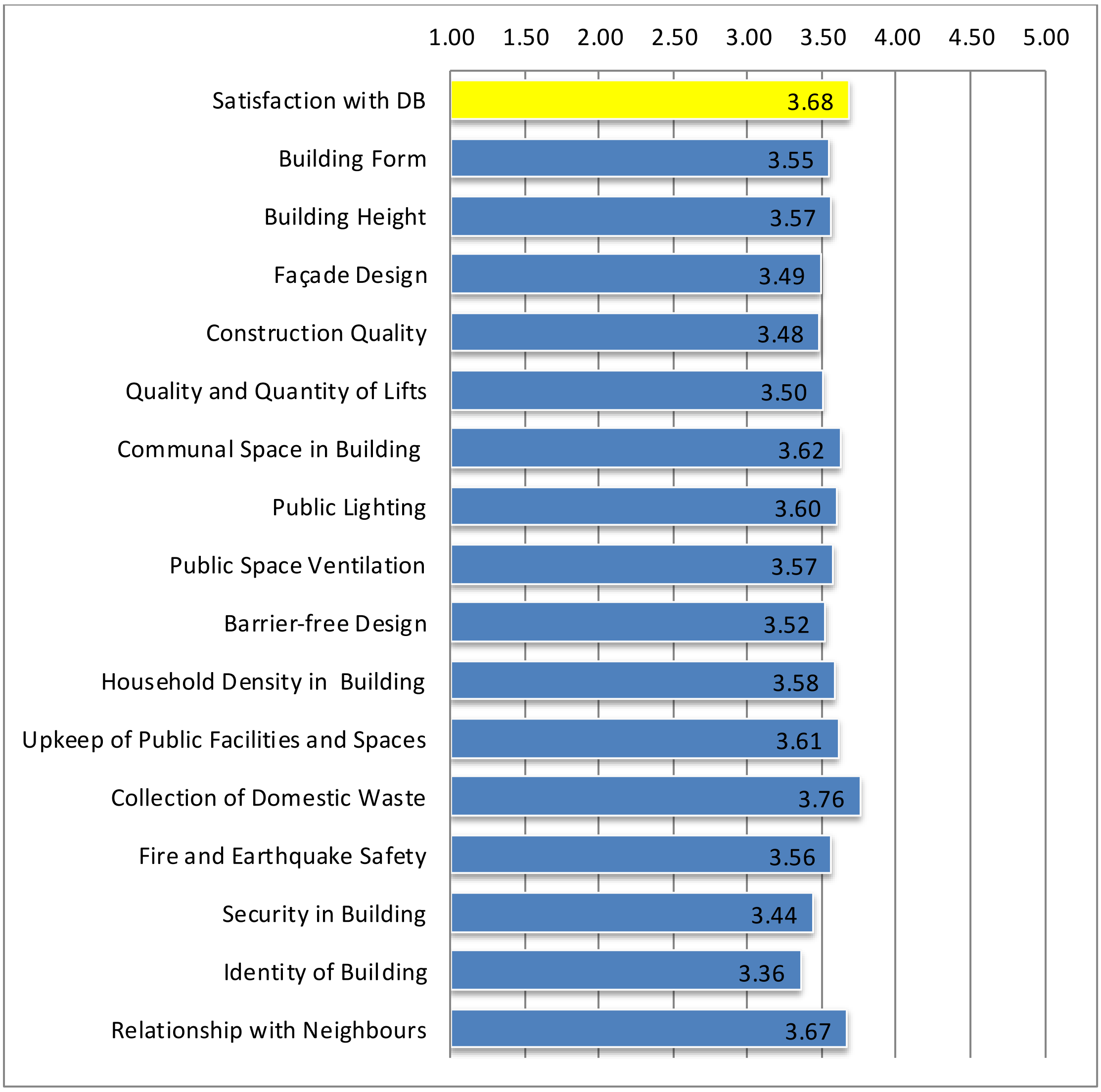


Figure 6- 25 Satisfaction Levels with Dwelling Building (DB) and its 16 Liveability Elements

Among all 16 elements at this spatial level, *identity of building* and *façade design* were given the lowest satisfaction rates (43.9% and 50.9% respectively). As argued earlier, in the race over opportunities to develop in the 'Golden Spot' of the city, developers' bids for inner-city lands continued to rise at a high speed. To maintain a decent profit, an obvious choice was to reduce on construction costs. As a result, monotonous building facade designs prevailed in all residential developments, leading to the loss of community identity. C*ollection of domestic waste* was given the highest satisfaction rate (73.8%) among all 16 elements. *Communal space* and *public lighting* were also considered satisfactory with over 65% positive ratings.

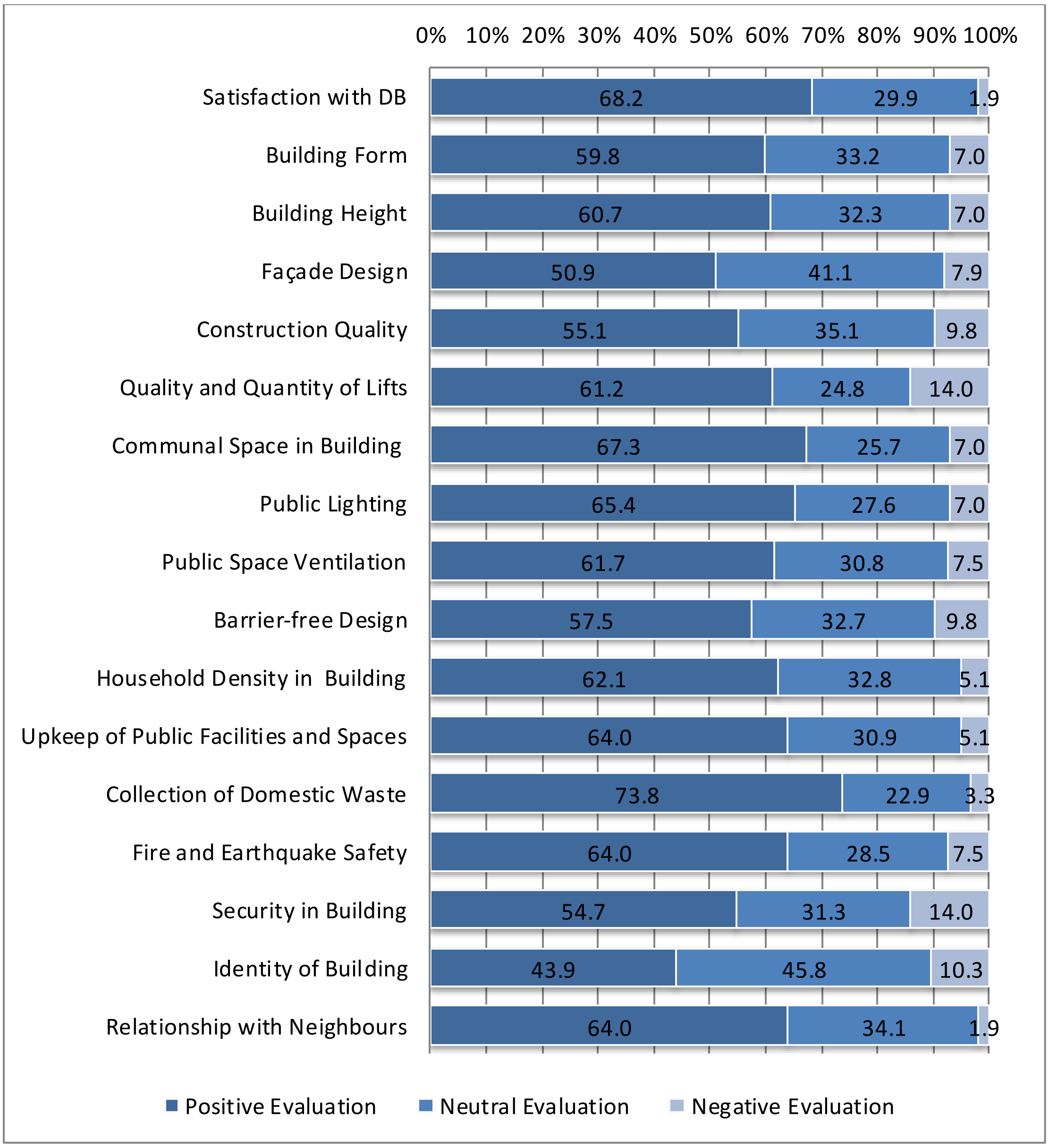


Figure 6- 26 Satisfaction Rate with Dwelling Building (DB) and its 16 Liveability Elements

4. Dwelling unit

At the level of dwelling unit, 18 liveability elements were examined (Figure 6-27). The element with the lowest satisfaction level was *property cost* (3.05), Other elements identified at the lower interval of between 3.0 and 3.5 are: *internal sound-proof* (3.09), *storage spaces* (3.13), *external sound-proof* (3.23), *private* *outdoor spaces* (3.33), and *structure quality* (3.41). The element with the highest satisfaction level is *Indoor heating* (3.91).

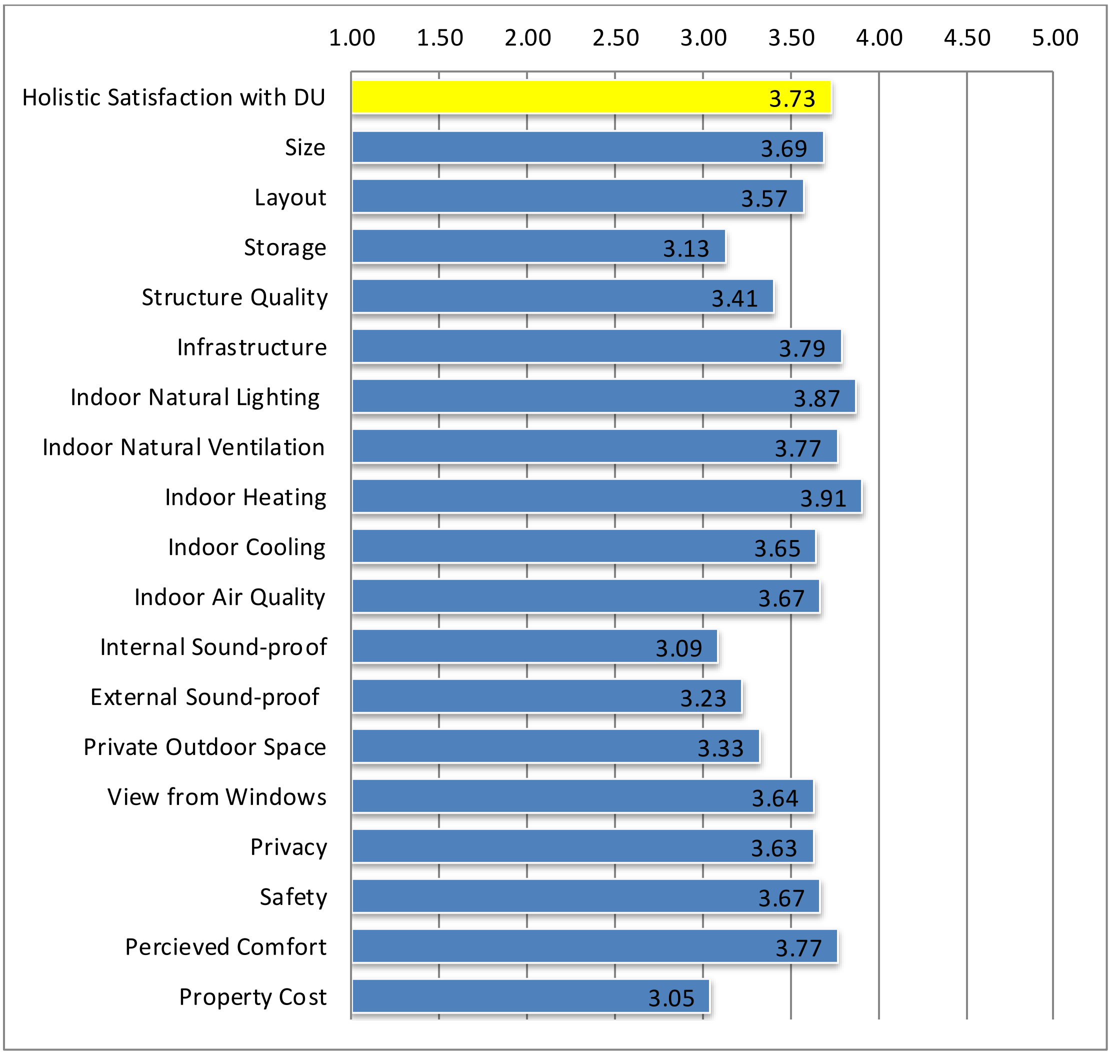


Figure 6- 27 Satisfaction Levels with Dwelling Unit (DU) and its 18 Liveability Elements

Property cost received the lowest satisfaction rate among all 18 liveability element at the spatial level of dwelling unit (Figure 6-28). Only 28.5% respondents were satisfied with their property cost that is composed of the rental or mortgage fee, property management fee, and costs of utilities. Obviously, the high cost of high-rise living is the most important liveability problems in the context of Tianjin. Both *indoor and outdoor noise pollution* accompanying high-density residential environment and poor sound-proof caused the low satisfaction rates (34.6% and 40.6% respectively) . The much higher costs of material and construction of high-rise housing than that of the other housing types resulted in the 'cost-optimized' design and construction, which led to the lack of auxiliary spaces such as *storage* and *balcony* and the low *structure quality*.

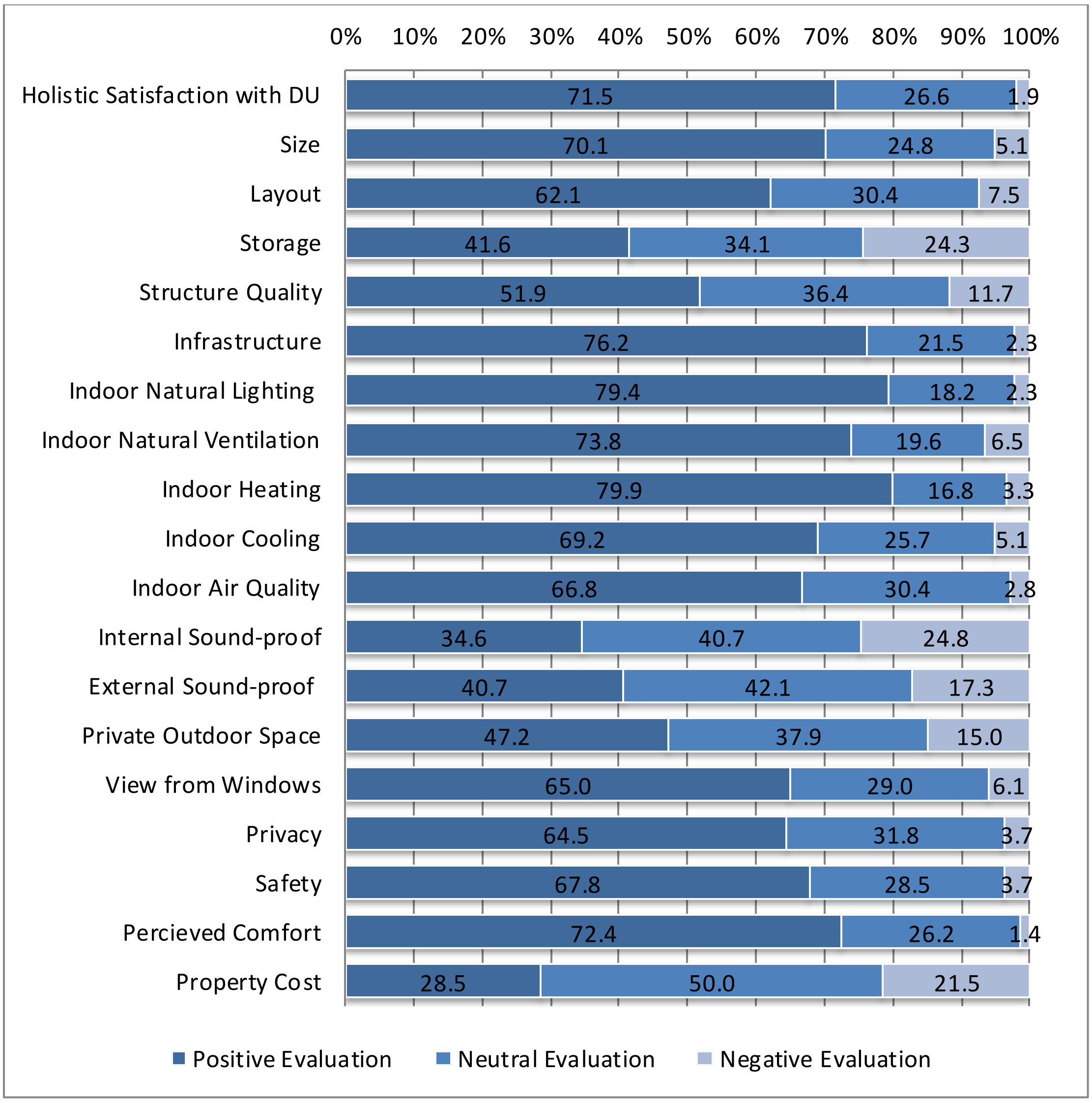


Figure 6- 28 Satisfaction Rate with Dwelling Unit (DU) and its 18 Liveability Elements

However, the fundamental liveability elements such as *indoor heating in winter* (3.91), *natural lighting* (3.87), *infrastructure* (3.79), and *natural ventilation* (3.77) achieved high satisfaction levels, which benefited from the improved urban infrastructure including the urban central heating system, electricity, water supply and sewerage system, and the strict control of building spacing in the codes of housing planning and design. In addition, in the psycho-social dimension, the satisfaction level with *perceived comfort within home* reached 3.77, and 72.4% of respondents expressed positive evaluation.

6.3.4 Summary

As Figure 6-29 showed, all of the satisfaction levels are located between 3.05

(*property cost*) and 3.91 (*indoor heating*) on a 5-point Likert scale. The result indicates that the comprehensive liveability evaluation of high-rise housing estates was located in the range between neutral (3.0) and positive (4.0) evaluation.

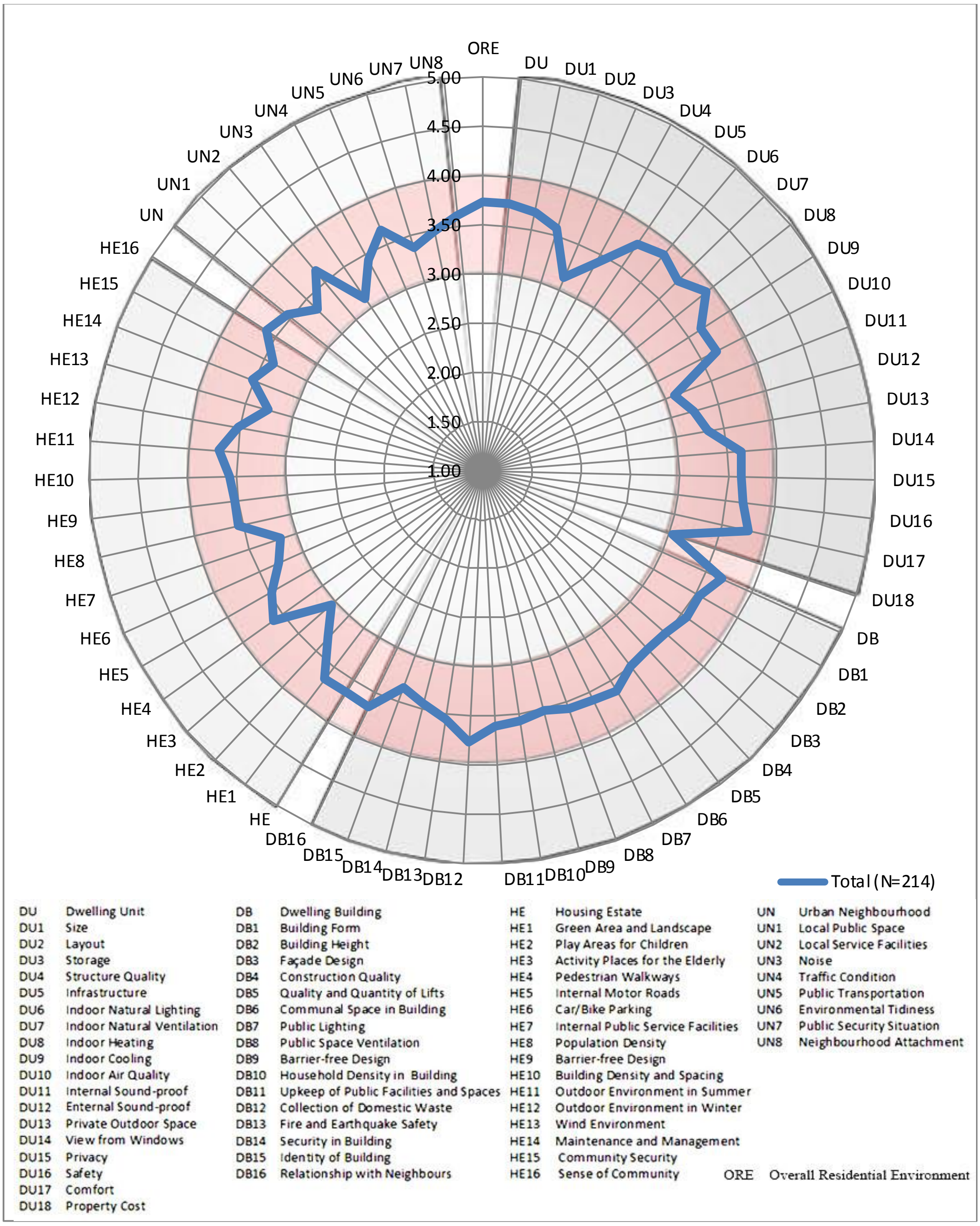
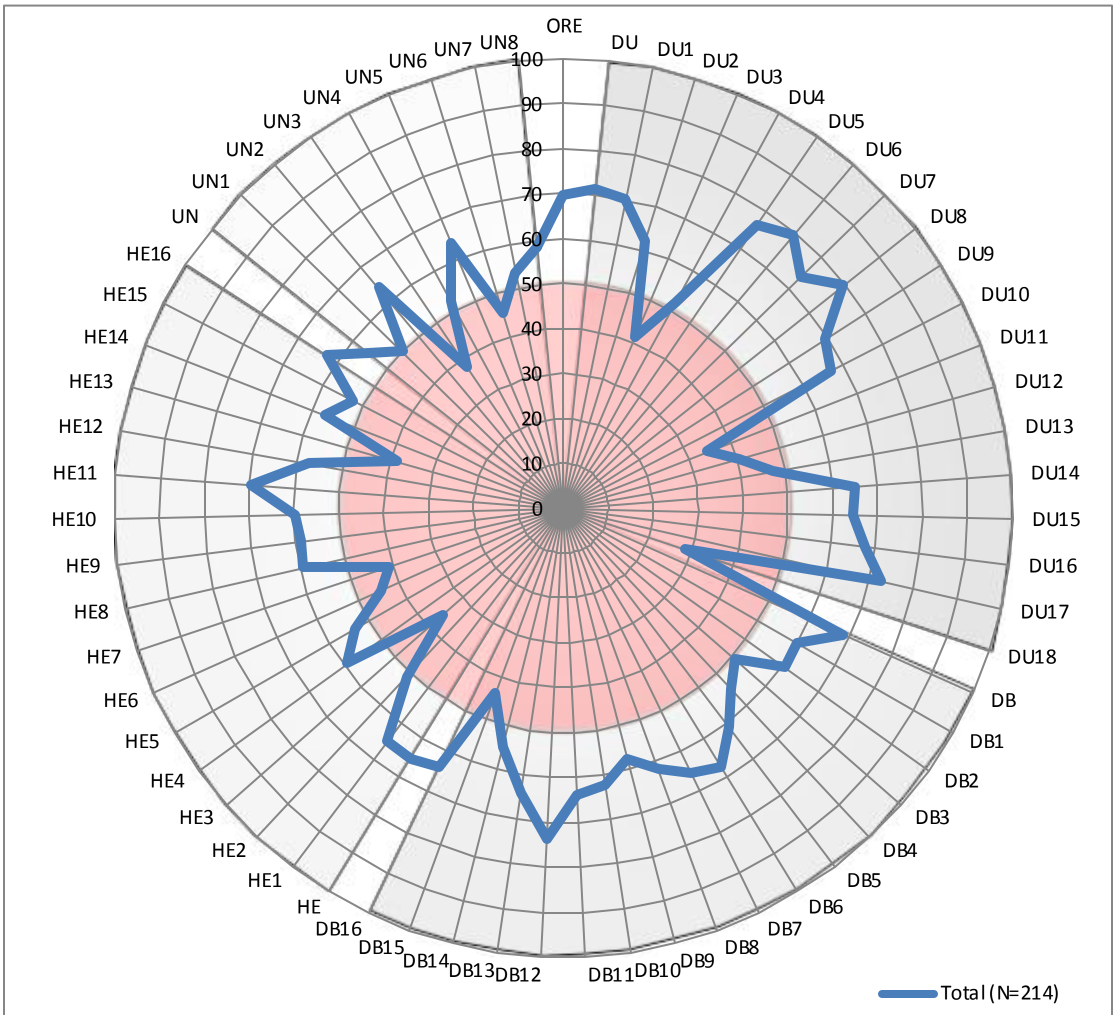


Figure 6- 29 Distributions of the Holistic Satisfaction Levels of Overall Residential Environment (ORE), Four Spatial Levels and 58 Liveability Elements

Furthermore, as Figure 6-30 showed, the distributions of the holistic satisfaction rates are ranged from 28.5% (Property cost) to 79.9% (Indoor heating). Among the 58 liveability elements, 12 ones' satisfaction rates are below 50%, they are dwelling unit's ***property cost, storage, private outdoor space, internal and external***

sound-proof, dwelling building's ***identity***, housing estate's ***activity place for the elderly, car parking, internal public service facilities,*** and ***wind environment***, urban neighbourhood's ***noise*** and ***tidiness,*** which reflected the main liveability problems.



DU	Dwelling Unit	DB	Dwelling Building	HE	Housing Estate	UN	Urban Neighbourhood
DU1	Size	DB1	Building Form	HE1	Green Area and Landscape	UN1	Local Public Space
DU2	Layout	DB2	Building Height	HE2	Play Areas for Children	UN2	Local Service Facilities
DU3	Storage	DB3	Façade Design	HE3	Activity Places for the Elderly	UN3	Noise
DU4	Structure Quality	DB4	Construction Quality	HE4	Pedestrian Walkways	UN4	Traffic Condition
DU5	Infrastructure	DB5	Quality and Quantity of Lifts	HE5	Internal Motor Roads	UN5	Public Transportation
DU6	Indoor Natural Lighting	DB6	Communal Space in Building	HE6	Car/Bike Parking	UN6	Environmental Tidiness
DU7	Indoor Natural Ventilation	DB7	Public Lighting	HE7	Internal Public Service Facilities	UN7	Public Security Situation
DU8	Indoor Heating	DB8	Public Space Ventilation	HE8	Population Density	UN8	Neighbourhood Attachment
DU9	Indoor Cooling	DB9	Barrier-free Design	HE9	Barrier-free Design		
DU10	Indoor Air Quality	DB10	Household Density in Building	HE10	Building Density and Spacing		
DU11	Internal Sound-proof	DB11	Upkeep of Public Facilities and Spaces	HE11	Outdoor Environment in Summer		
DU12	External Sound-proof	DB12	Collection of Domestic Waste	HE12	Outdoor Environment in Winter		
DU13	Private Outdoor Space	DB13	Fire and Earthquake Safety	HE13	Wind Environment		
DU14	View from Windows	DB14	Security in Building	HE14	Maintenance and Management		
DU15	Privacy	DB15	Identity of Building	HE15	Community Security		
DU16	Safety	DB16	Relationship with Neighbours	HE16	Sense of Community	ORE	Overall Residential Environment
DU17	Comfort						
DU18	Property Cost						

Figure 6- 30 Distributions of the Holistic Satisfaction Rates of Overall Residential Environment (ORE), Four Spatial Levels and 58 Liveability Elements

6.4 Comparison of liveability evaluation of the four study cases

As analysed in *Chapter 4* (macro-context analysis) and *Chapter 5* (residential environment analysis of the four study cases), the four study cases in the context of the inner city of Tianjin respectively represent 4 typologies of high-rise housing estates being developed in China. Through the comparison of liveability evaluation between the study cases, the liveability of the 4 typologies of high-rise housing estates can be further explored. This section compared the survey data of the four study cases from the three hierarchical layers: the overall residential environment, the 4 spatial levels, and 58 liveability elements.

6.4.1 Study case comparison of evaluation and satisfaction of the overall residential environment

From the perspective of the four study cases, Case 1, 2, and 3 obtained relatively high evaluation and satisfaction levels with overall residential environment, and the evaluation of Case 2 even reached 4.00 (Figure 6-31). However, Case 4 with the highest development intensity only achieved 3.30 on evaluation and 3.14 on satisfaction.

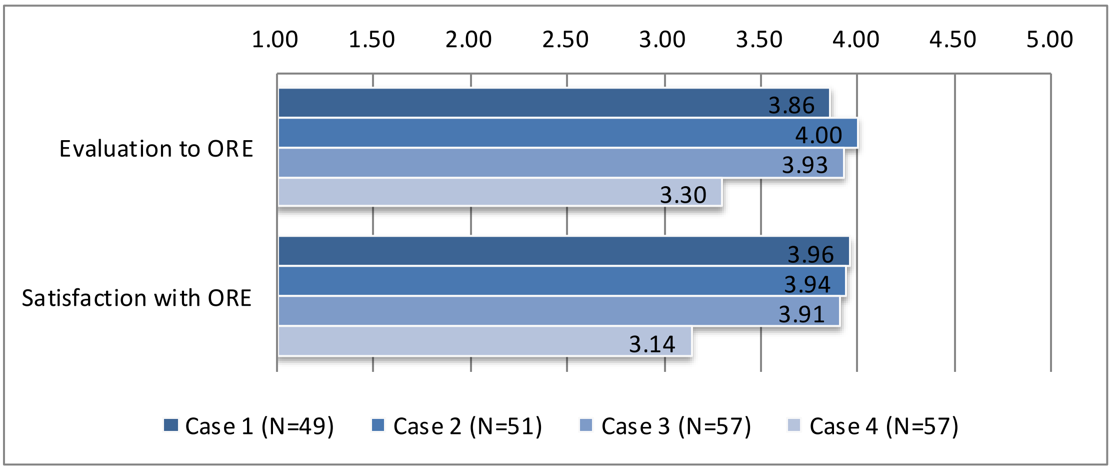


Figure 6- 31 Evaluation and Satisfaction with Overall Residential Environment (ORE) of the High-rise housing estates

One-way Analysis of Variance (ANOVA) was carried out to compare the mean values of the evaluation and satisfaction with overall residential environment in the four study cases. According to the guideline of Andy Field (Field 2005), the Games-Howell procedure is the most powerful even though the sample sizes are very different. Therefore it was used as the method of multiple comparisons. The results indicated that the differences of both evaluations and satisfactions among Case 1, 2, and 3 were not significant, but the differences between them and Case 4 were highly significant (*p*<.*001*, Table 6-10).

Table 6- 10 Multiple Comparisons of the Mean values of Evaluation and Satisfaction with Overall Residential Environment (ORE) of the Four Study Cases

Multiple Comparisons							
Games-Howell							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Evaluation of ORE	Case 1	Case 2	-.143	.122	.647	-.46	.18
	Case 1	Case 3	-.073	.130	.944	-.41	.27
	Case 1	***Case 4***	***.559****	***.128***	***.000***	***.22***	***.89***
	Case 2	Case 3	.070	.107	.914	-.21	.35
	Case 2	***Case 4***	***.702****	***.105***	***.000***	***.43***	***.97***
	Case 3	***Case 4***	***.632****	***.114***	***.000***	***.33***	***.93***
Satisfaction of ORE	Case 1	Case 2	.018	.092	.997	-.22	.26
	Case 1	Case 3	.047	.110	.974	-.24	.33
	Case 1	***Case 4***	***.819****	***.119***	***.000***	***.51***	***1.13***
	Case 2	Case 3	.029	.103	.992	-.24	.30
	Case 2	***Case 4***	***.801****	***.112***	***.000***	***.51***	***1.09***
	Case 3	***Case 4***	***.772****	***.127***	***.000***	***.44***	***1.10***
*. The mean difference is significant at the 0.05 level.							

It can be concluded that both evaluation and satisfaction of Case 4 were significantly lower than those of Case 1, Case 2, and Case 3, while the difference among the other three cases were not significant. On the whole, the residential environment of Case 4 demonstrated comparatively poor performance of liveability (Figure 6-32).

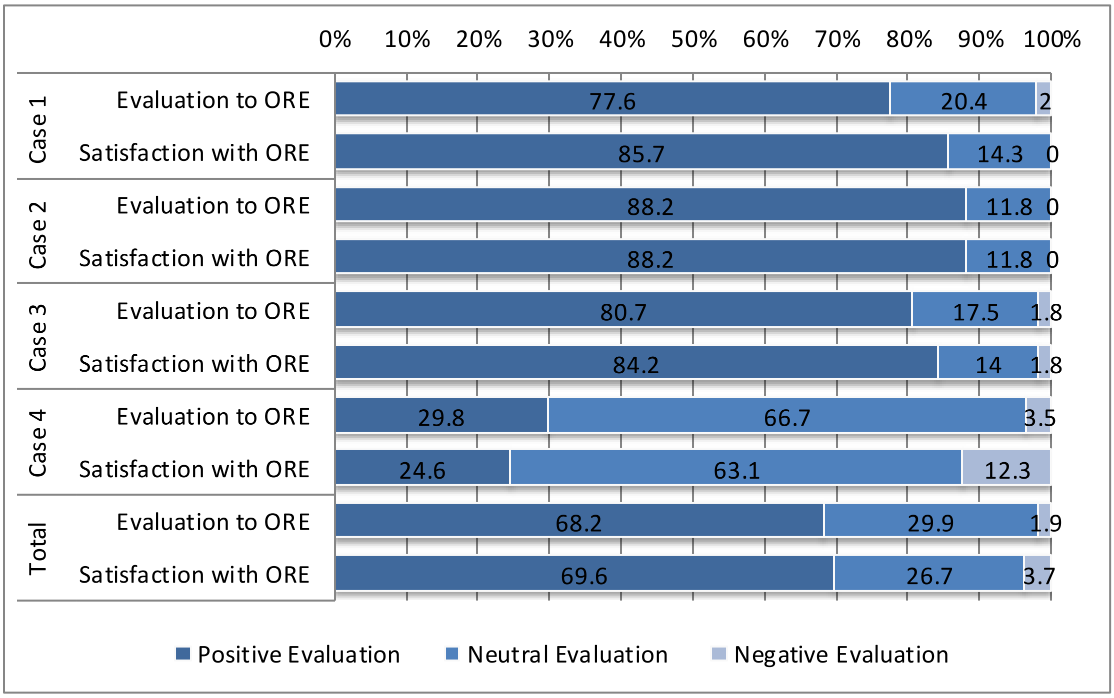


Figure 6- 32 Distribution of Evaluation and Satisfaction with Overall Residential Environment (ORE) of the Four Study Cases

6.4.2 Study Case comparison of the satisfaction with the four spatial levels

Among all study cases, Case 2 had the highest satisfaction levels at all four spatial levels (urban neighbourhood, housing estate, dwelling building and dwelling unit) (Figure 6-33). As analysed in Chapter 5, Case 2 is located in a mature urban neighbourhood where the urban regeneration had been completed in 2007. With the relatively low development intensity, the planning and community management of Case 2 was better than the other cases. The combination of diversified dwelling buildings helped create an abundant and comfortable community environment. The architecture design of dwelling buildings showed a high standard and created a good community image, and the layout and size of dwelling units were also more practical.

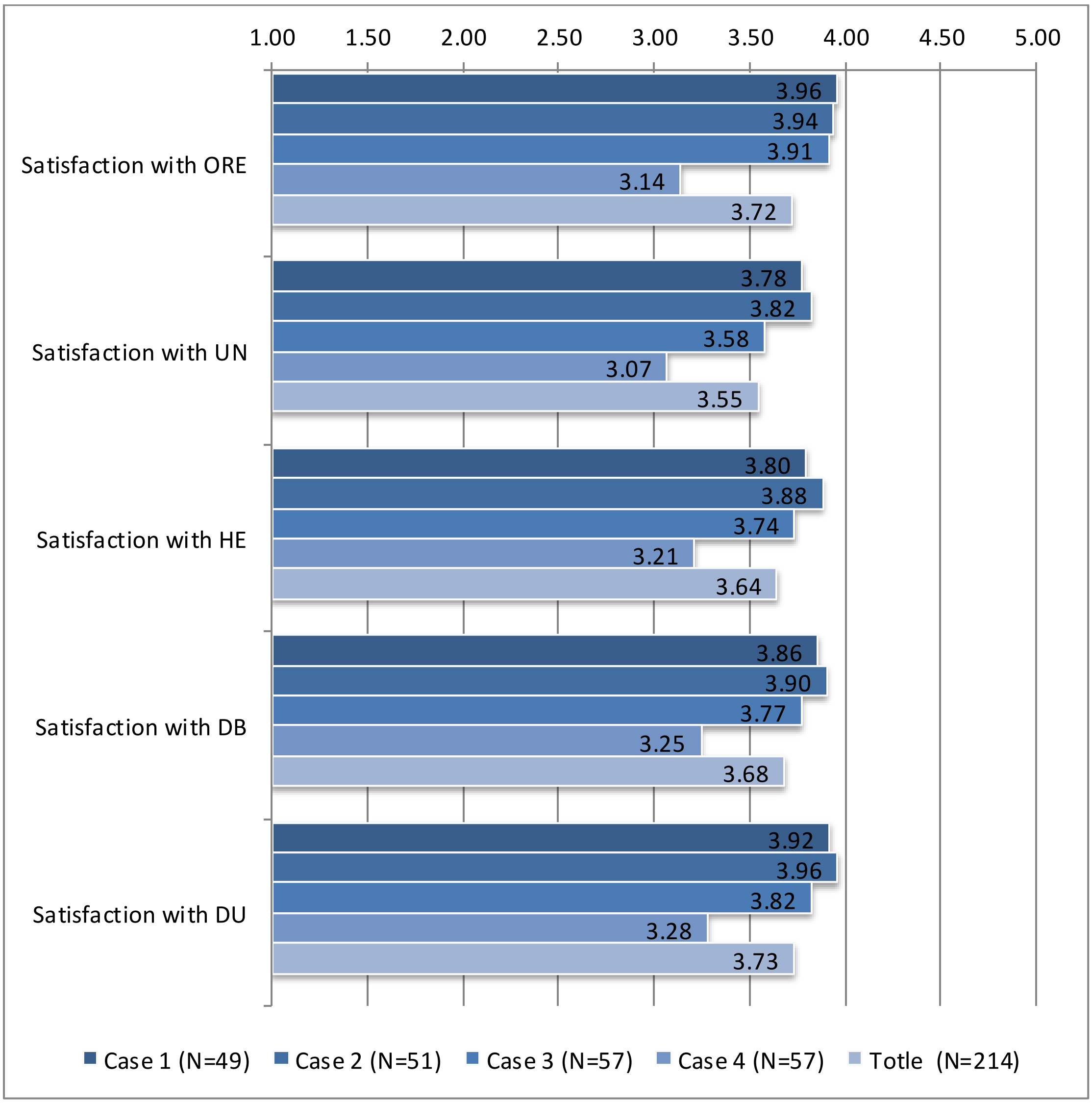


Figure 6- 33 Satisfaction Levels of Overall Residential Environment (ORE) and four spatial levels: Urban Neighbourhood (UN), Housing Estate (HE), Dwelling Building (DB), and Dwelling Unit (DU) in the Four Study Cases

As Figure 6-33 shows, both the evaluation and satisfaction of Case 3 was the second lowest among all study cases, which is somewhat inconsistent with the analysis in Chapter 5, which showed that the planning, design and management of Case 3 was to a high standard. The result indicates the complex relationships between residents' perception with both physical and psycho-social dimensions of high quality residential environment. In other words, high investment in the construction of physical environment does not necessarily bring about high satisfaction level of the users.

Comparing the satisfaction ratings on the four spatial levels, a common phenomenon can be found in all study cases, that is: **the satisfaction level was the highest for the spatial level of dwelling unit, and gradually decreased in dwelling building, housing estate, and was the lowest for urban neighbourhood**. The result indicates that, there exists a trend that 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 were situated in. The outcome can be interpreted from two perspectives:

1) As a form of collective living, high-rise residential environment necessitates the sharing of facilities at all spatial levels and that the higher the spatial level the more people would share the use of communal services. The collective usage of certain public facilities on a daily-basis may induce more dissatisfaction;

2) As recently developed gated communities in previously dilapidated urban neighbourhoods, the high-rise housing estates in Tianjin all seek to showcase high-quality living within their gates, while turning their back on the outer neighbourhoods, which may even be further deteriorated by the invasion of increasing numbers of gated high-rise developments. This implies the necessity of improving the urban neighbourhood for an enhanced residential liveability in the inner city.

One-way ANOVA based on Games-Howell procedure has been carried out to compare the means of the satisfaction with the four spatial levels in the study cases. The result showed that the satisfaction level of Case 4 was significantly lower than those of the other cases ($p < .001$, Table 6-11).

Table 6- 11 Multiple Comparisons of the Mean Values of Satisfaction with the Four Spatial Levels of the Four Studies Cases

Multiple Comparisons							
Games-Howell							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Satisfaction of UN	Case 1	Case 2	-.048	.103	.966	-.32	.22
	Case 1	Case 3	.197	.105	.243	-.08	.47
	Case 1	***Case 4***	***.705****	***.104***	***.000***	***.43***	***.98***
	Case 2	Case 3	.245	.104	.094	-.03	.52
	Case 2	***Case 4***	***.753****	***.104***	***.000***	***.48***	***1.02***
	Case 3	***Case 4***	***.509****	***.106***	***.000***	***.23***	***.78***
Satisfaction of HE	Case 1	Case 2	-.086	.101	.829	-.35	.18
	Case 1	Case 3	.059	.105	.943	-.22	.33
	Case 1	***Case 4***	***.585****	***.109***	***.000***	***.30***	***.87***
	Case 2	Case 3	.146	.106	.517	-.13	.42
	Case 2	***Case 4***	***.672****	***.109***	***.000***	***.39***	***.96***
	Case 3	***Case 4***	***.526****	***.113***	***.000***	***.23***	***.82***
Satisfaction of DB	Case 1	Case 2	-.045	.082	.948	-.26	.17
	Case 1	Case 3	.085	.093	.796	-.16	.33
	Case 1	***Case 4***	***.612****	***.097***	***.000***	***.36***	***.87***
	Case 2	Case 3	.130	.083	.406	-.09	.35
	Case 2	***Case 4***	***.656****	***.088***	***.000***	***.43***	***.89***
	Case 3	***Case 4***	***.526****	***.098***	***.000***	***.27***	***.78***
Satisfaction of DU	Case 1	Case 2	-.042	.080	.952	-.25	.17
	Case 1	Case 3	.094	.089	.719	-.14	.33
	Case 1	***Case 4***	***.638****	***.104***	***.000***	***.37***	***.91***
	Case 2	Case 3	.136	.078	.311	-.07	.34
	Case 2	***Case 4***	***.680****	***.095***	***.000***	***.43***	***.93***
	Case 3	***Case 4***	***.544****	***.103***	***.000***	***.28***	***.81***
*. The mean difference is significant at the 0.05 level.							

It is worth noting that the satisfaction rate of dwelling building (29.8%) was lower than that of housing estate (31.6%) in Case 4 consisting of short-slab and tower high-rise dwelling buildings, which was a significant difference between Case 4 and the other cases (Figure 6-34). Moreover, the satisfaction rate with urban neighbourhood of Case 4 that was located in a brand new neighbourhood was 57.9%. In comparison, the satisfaction rates of the other spatial levels in Case 1, Case 2 and Case 3 were all over 70%.

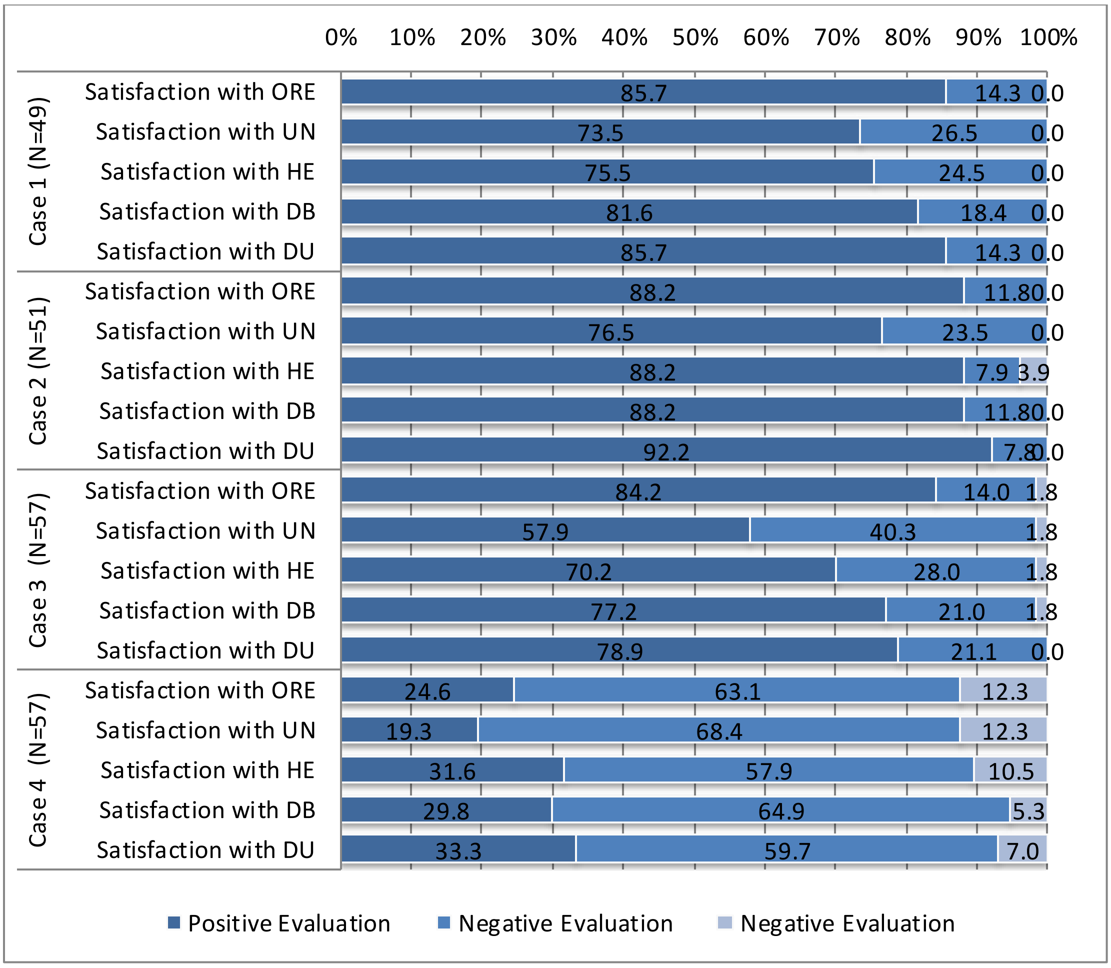


Figure 6- 34 Satisfaction Rates of Overall Residential Environment (ORE) and four spatial levels: Urban Neighbourhood (UN), Housing Estate (HE), Dwelling Building (DB), and Dwelling Unit (DU) in the Four Study Cases

6.4.3 Study case comparison of the satisfaction with the 58 liveability elements

In this section, through the multiple comparisons of the satisfaction levels of the 58 liveability elements in the 4 cases, the general and specific liveability problems of high-rise housing estates can be further revealed from the four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit.

1. Urban neighbourhood

The qualitative survey in *Chapter 5* indicated that Case 1 was located in a semi-mature urban neighbourhood; Case 2 was located in a mature neighbourhood; Case 3 was located in a brand new neighbourhood; and Case 4 was located in a mixed old and new neighbourhood under regeneration.

As Figure 6-35 showed, the evaluations of all 8 liveability elements in Case 4 were the lowest among the four study cases, and the satisfaction levels with ***noise*** (2.58),

local public space (2.61) and ***environmental tidiness*** (2.96) were below the medium value of 3. Obviously, the urban neighbourhood under regeneration where Case 4 was located indeed existed many problems that have been analysed in *Section 5.6*. In terms of ***noise*** (3.14), ***local public space*** (3.26), ***traffic condition*** (3.32) and ***environment tidiness*** (3.40), Case 3 obtained relatively low satisfactions in spite of its being a brand new neighbourhood that has just been redeveloped and completed in 2011. This indicates that current high-intensity and high-density urban redevelopment are inadequate in providing good liveability. ***Noise*** and ***environment tidiness*** were also given relatively low satisfaction levels in Case 1 and Case 2, which were considered to be located in mature neighbourhoods.

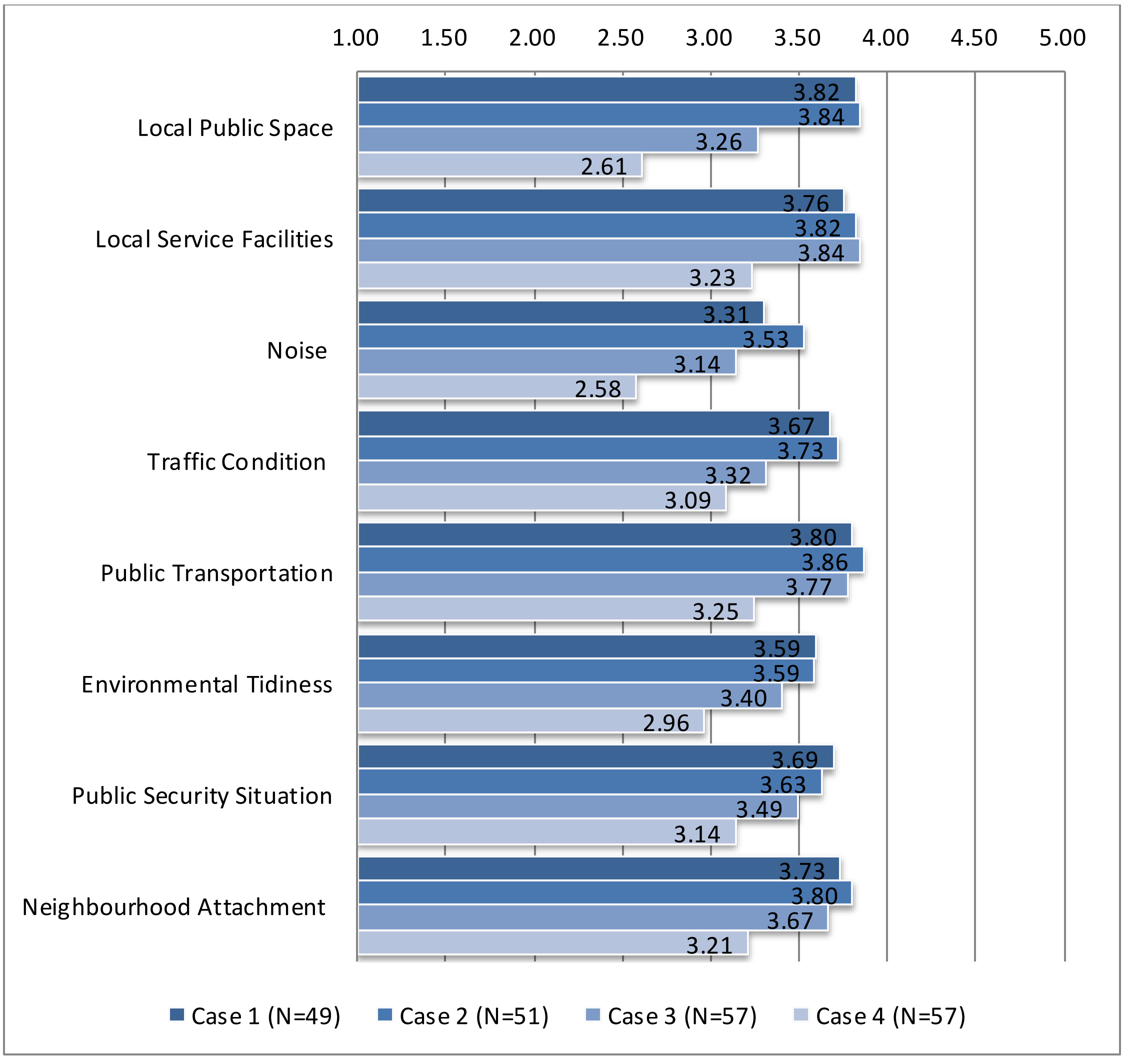


Figure 6- 35 Satisfaction Levels with the 8 Liveability Elements of Urban Neighbourhood (UN) in the Four Study Cases

One-way ANOVA was carried out to compare the mean values of the 8 liveability elements in the four study cases (Table 6-12). The results indicated that there was no significant difference between Case 1 and Case 2 in all of the 8 liveability elements.

The satisfaction levels with *local public space* and *traffic conditions* of Case 1 and Case 2 were significantly higher than those of Case 3 which was located in a brand new neighbourhood. Except *traffic conditions*, the satisfaction levels of the other 7 elements of Case 4 were significantly lower than those of Case 1, 2, and 3, which faithfully reflect the actual situations of the neighbourhood under regeneration.

Table 6- 12 Multiple Comparisons of Means of Satisfactions with the 8 Liveability Elements of Urban Neighbourhood

Multiple Comparisons							
Games-Howell							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Local public space	Case 1	Case 2	-.027	.103	.994	-.30	.24
	Case 1	***Case 3***	***.553****	***.129***	***.000***	***.22***	***.89***
	Case 1	***Case 4***	***1.202****	***.127***	***.000***	***.87***	***1.53***
	Case 2	***Case 3***	***.580****	***.126***	***.000***	***.25***	***.91***
	Case 2	***Case 4***	***1.229****	***.124***	***.000***	***.90***	***1.55***
	Case 3	***Case 4***	***.649****	***.147***	***.000***	***.27***	***1.03***
Local service facilities	Case 1	Case 2	-.068	.116	.934	-.37	.23
	Case 1	Case 3	-.087	.124	.897	-.41	.24
	Case 1	***Case 4***	***.527****	***.130***	***.001***	***.19***	***.87***
	Case 2	Case 3	-.019	.112	.998	-.31	.28
	Case 2	***Case 4***	***.595****	***.119***	***.000***	***.29***	***.90***
	Case 3	***Case 4***	***.614****	***.127***	***.000***	***.28***	***.95***
Noise	Case 1	Case 2	-.223	.142	.400	-.60	.15
	Case 1	Case 3	.166	.164	.742	-.26	.59
	Case 1	***Case 4***	***.727****	***.151***	***.000***	***.33***	***1.12***
	Case 2	Case 3	.389	.151	.055	-.01	.78
	Case 2	***Case 4***	***.950****	***.137***	***.000***	***.59***	***1.31***
	Case 3	***Case 4***	***.561****	***.159***	***.003***	***.15***	***.98***
Traffic conditions	Case 1	Case 2	-.052	.112	.967	-.35	.24
	Case 1	***Case 3***	***.358****	***.131***	***.036***	***.02***	***.70***
	Case 1	***Case 4***	***.586****	***.118***	***.000***	***.28***	***.89***
	Case 2	***Case 3***	***.410****	***.131***	***.012***	***.07***	***.75***
	Case 2	***Case 4***	***.638****	***.118***	***.000***	***.33***	***.95***
	Case 3	Case 4	.228	.136	.340	-.13	.58
Public transportation	Case 1	Case 2	-.067	.111	.931	-.36	.22
	Case 1	Case 3	.024	.123	.997	-.30	.35
	Case 1	***Case 4***	***.550****	***.126***	***.000***	***.22***	***.88***
	Case 2	Case 3	.091	.111	.845	-.20	.38
	Case 2	***Case 4***	***.617****	***.114***	***.000***	***.32***	***.92***
	Case 3	***Case 4***	***.526****	***.126***	***.000***	***.20***	***.85***
Environment tidiness	Case 1	Case 2	.004	.124	1.000	-.32	.33
	Case 1	Case 3	.188	.122	.413	-.13	.51
	Case 1	***Case 4***	***.627****	***.119***	***.000***	***.32***	***.94***
	Case 2	Case 3	.185	.130	.487	-.15	.52
	Case 2	***Case 4***	***.623****	***.128***	***.000***	***.29***	***.96***
	Case 3	***Case 4***	***.439****	***.125***	***.003***	***.11***	***.76***
Public security situation	Case 1	Case 2	.066	.115	.938	-.23	.37
	Case 1	Case 3	.203	.114	.293	-.10	.50
	Case 1	***Case 4***	***.554****	***.128***	***.000***	***.22***	***.89***
	Case 2	Case 3	.136	.118	.659	-.17	.45
	Case 2	***Case 4***	***.487****	***.132***	***.002***	***.14***	***.83***
	Case 3	***Case 4***	***.351****	***.131***	***.043***	***.01***	***.69***
Neighbourhood attachment	Case 1	Case 2	-.069	.098	.895	-.33	.19
	Case 1	Case 3	.068	.107	.920	-.21	.35
	Case 1	***Case 4***	***.524****	***.099***	***.000***	***.27***	***.78***
	Case 2	Case 3	.137	.106	.567	-.14	.41
	Case 2	***Case 4***	***.593****	***.098***	***.000***	***.34***	***.85***
	Case 3	***Case 4***	***.456****	***.106***	***.000***	***.18***	***.73***
*. The mean difference is significant at the 0.05 level.							

The satisfaction rates of the 8 liveability elements in the four study cases intuitively revealed the liveability issues (Figure 6-36). For Case 1 and Case 2, without significant differences on satisfaction with all 8 liveability elements between them, according to the above outcomes of ANOVA, the common issues identified were *noise*, *environment tidiness* and *public security situations*. Case 3 obtained low satisfaction rates with *noise* (38.6%), *local public space* (40.4%), *environment tidiness* (43.9%), *traffic conditions* (43.9%) and *public security situations* (49.1%). The satisfaction rates of all of the 8 liveability elements in Case 4 were lower than 40%, especially the satisfaction with *local public space* (8.8%), *noise* (10.5%) and *environment tidiness* (17.5%), which were even below 20%. In addition, the dissatisfaction rates of *noise* and *local public spaces* reached 45.6% and 43.9% respectively.

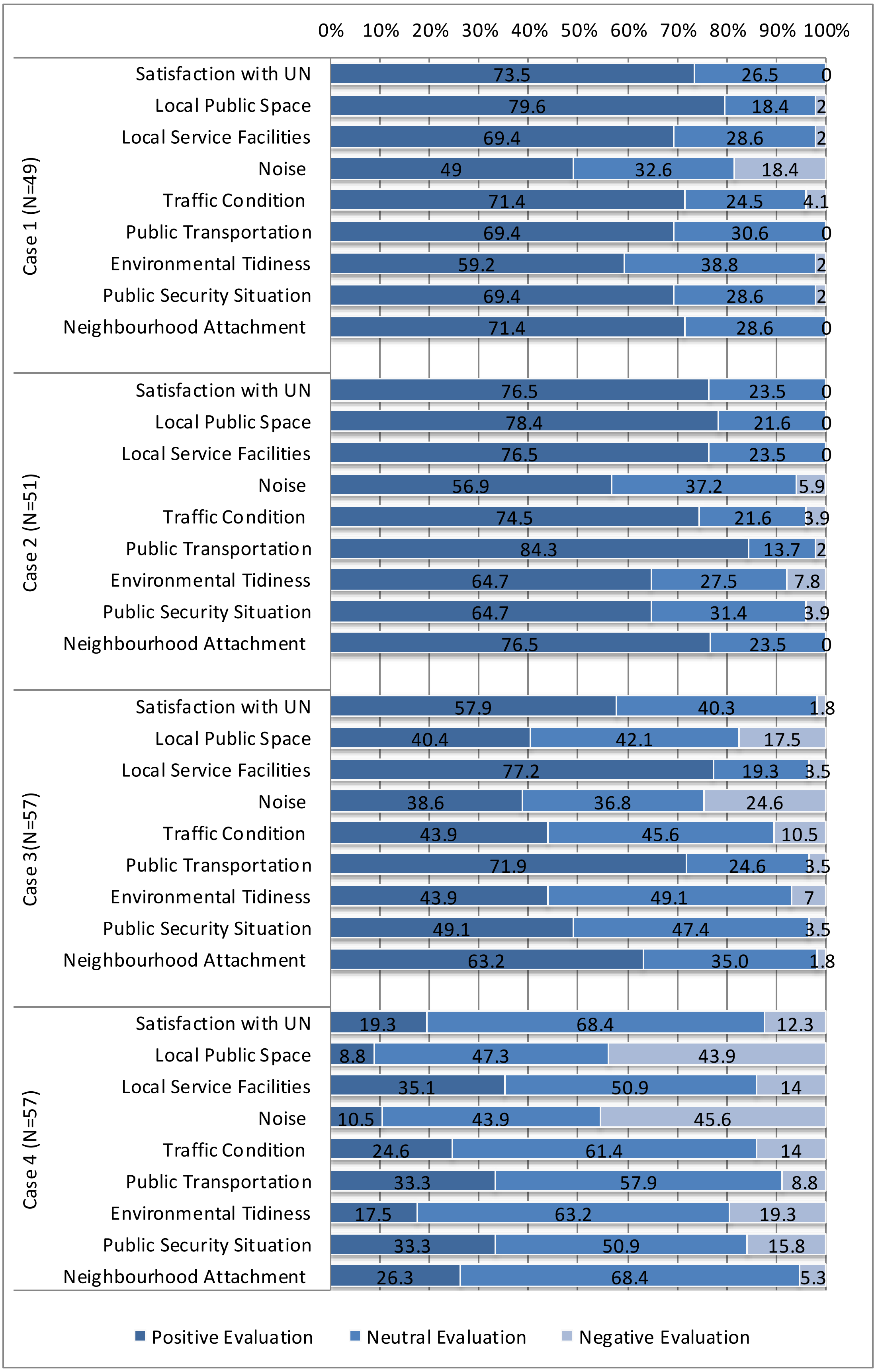


Figure 6- 36 Satisfaction Rates with the 8 Liveability Elements of Urban Neighbourhood (UN) in the Four Study Cases

To sum up, as analysed in *Chapter 5*, the four study cases were located in different urban neighbourhoods with varying degrees of maturity, which inevitably generated different levels of liveability in each study case. As showed in Figure 6-37, the mature neighbourhood (Case1 and Case 2) obtained the best comprehensive performance, followed by the brand new one (Case 3) and the one under regeneration (Case 4). ***Noise pollution,*** including traffic noise and construction noise, is the key common liveability issue on urban neighbourhoods with high-density development. Poor ***environment tidiness*** and ***public security*** reflected the shortcomings of the current urban management at the urban neighbourhood level, which had given rise to the prevailing of gated communities. Last but not least, consistent with the discussions in Section 5.7, the mature neighbourhoods (Case 1 and Case 2) provided better ***public spaces*** and ***traffic conditions*** than the new neighbourhoods (Case 3 and Case 4). In the context of rapidly increasing development intensity in the inner city of Tianjin, ***the local public spaces*** have been seriously neglected by governments and developers, and the excessive development have resulted in ***traffic congestion*** especially in the new redevelopment areas that were similar with the urban neighbourhoods where Case 3 and Case 4 were located in.

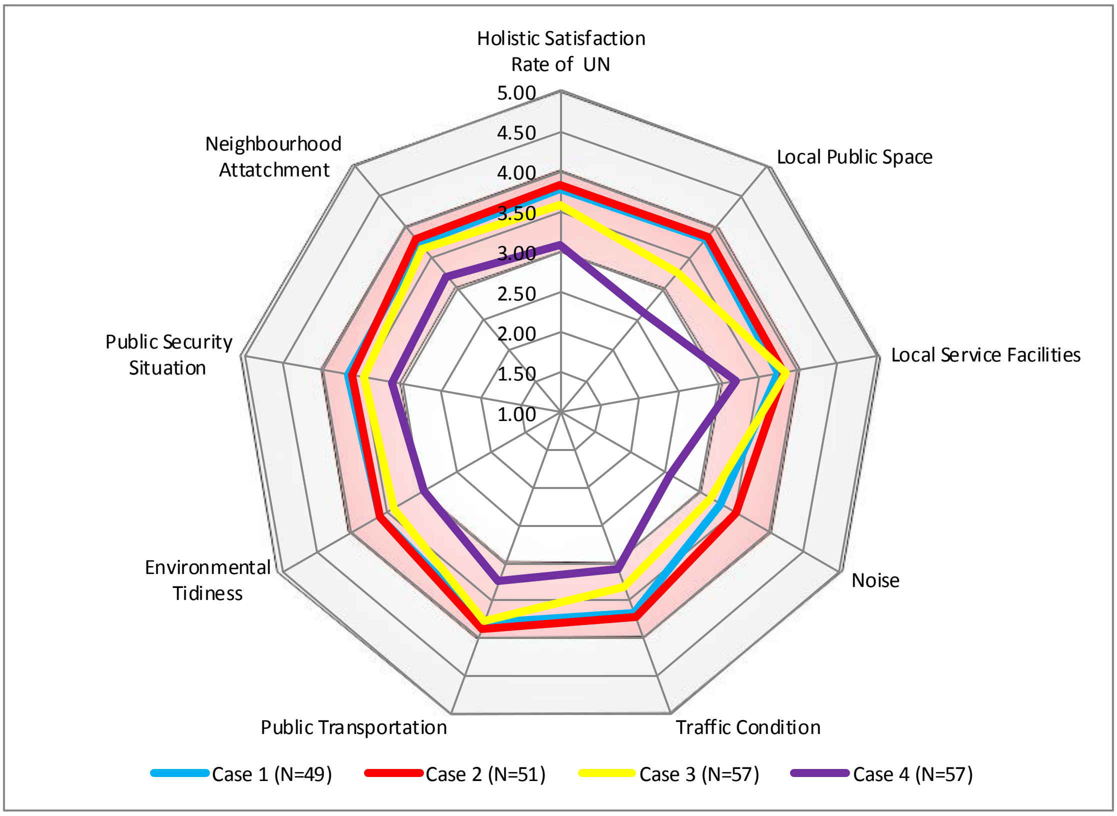


Figure 6- 37 Radar Chart of the Satisfaction Level of Urban Neighbourhood (UN) and its 8 Liveability Elements

2. Housing estate

As a development unit, housing estates were planned, designed, constructed, and managed as a whole in the context of urban planning in China. Thus the differences among the four study cases, that respectively represented 4 typologies appearing one after the other in the past decade of urban regeneration in the inner city of Tianjin, reflected the characteristics of the planning and design of each type of high-rise housing estates in pursuit of higher development intensity and profit. Case 1 represented the early high-rise housing estates with relatively low development intensity and rough planning, design and community management; Case 2 was the deputation of high-rise housing estate with low development intensity and careful planning, design and management; Case 3 was a new high-rise housing estate with high development intensity and standardized planning, design and community management; Being the most recent one, Case 4 illustrated the high-rise housing estates pursuing excessive development intensity and profit, while ignoring planning, design and management.

In Case 4, excessive pursuit of development intensity and return on investment resulted in serious liveability problems in the respects of ***internal public service facilities*** (2.28), ***play areas for children*** (2.35), ***activity places for the elderly*** (2.39), ***community security*** (2.93), ***wind environment*** (2.96), ***car/bike parking*** (2.98) and ***green area and landscape*** (2.98), which were rated below the medium value 3 (Figure 6-38). Although Case 4 did not do well in most liveability aspects, it obtained higher satisfactions with *internal motor roads* (3.25) and *car/bike parking* (2.98) than Case 1, which indicated the planning trend to accommodate for the rapidly increasing number of private cars in later stages of urban regeneration.

In contrast, Case 3 with the second highest development intensity did much better than Case 4 in these aspects, which provided strong evidence that high-quality planning, design, and management can effectively improve the performance of certain liveability elements including ***green area and landscape*** (3.95), ***pedestrian walkways*** (3.93), ***sense of community*** (3.86), and ***outdoor environment in summer*** (3.82) while maintaining high development intensity. Case 2 obtained relatively low satisfaction in the areas of: ***activity places for the elderly*** (3.24), ***internal public service facilities*** (3.47), ***car/bike parking*** (3.49) and ***community security*** (3.49), while obtaining high satisfaction with ***green area and landscape*** (4.04), ***outdoor environment in summer*** (3.92), and ***pedestrian walkways*** (3.90). The liveability problems of Case 1 were mainly reflected in the low satisfaction with ***car/bike parking*** (2.88), ***internal motor roads*** (3.20), ***wind environment*** (3.20), ***population density*** (3.43), and ***pedestrian walkways*** (3.49), which indicated the shortcomings of planning and design of early high-rise housing estates in Tianjin, China.

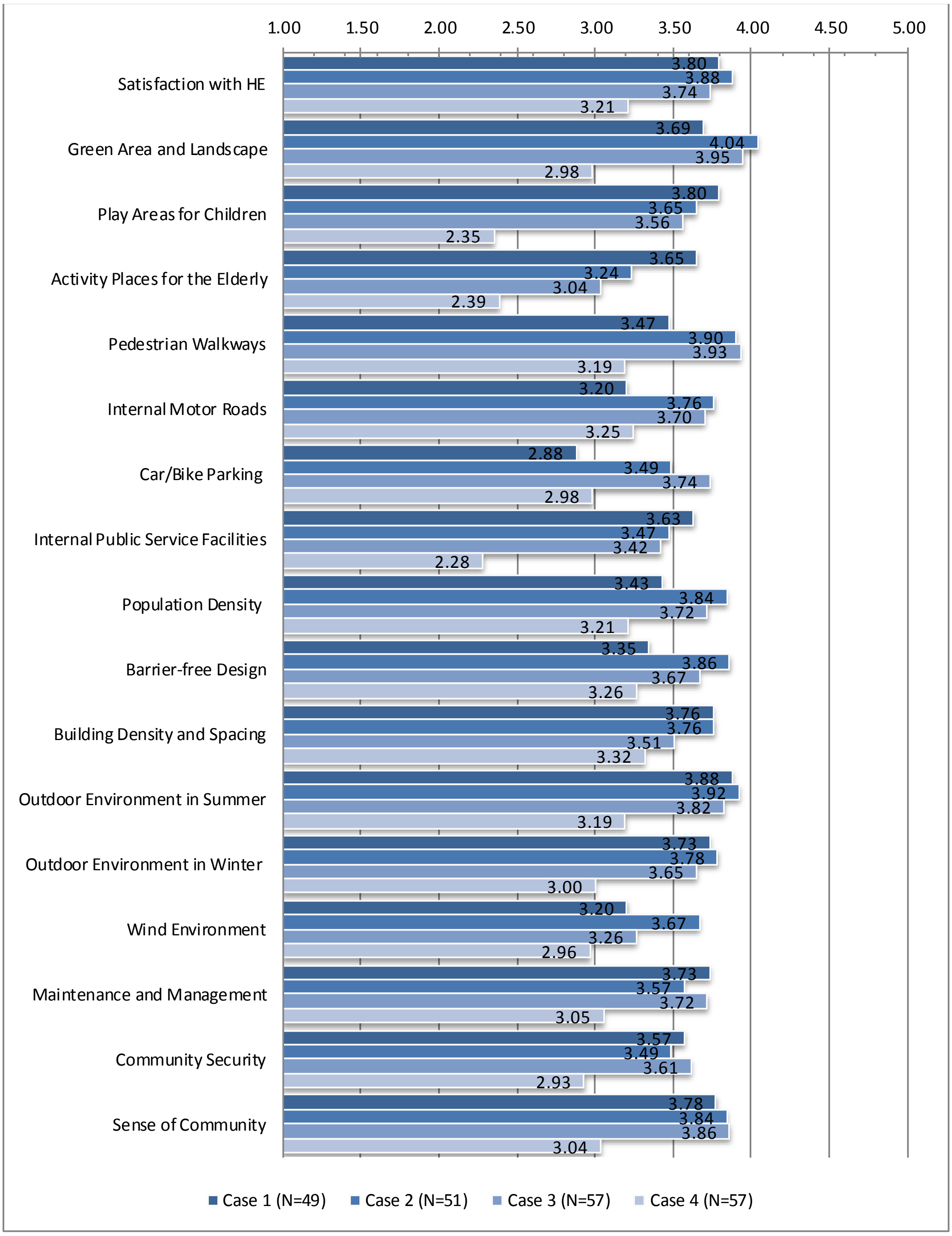


Figure 6- 38 Satisfaction Levels with the 16 Liveability Elements of Housing Estate (HE) in the Four Study Cases

Through the multiple comparisons of satisfaction means based on the statistics approach of One-way ANOVA, the differences in the satisfaction levels with the liveability elements among the 4 cases presented a complicated situation (Table 6-13), which provided evidences to support the findings of the qualitative survey in *Chapter 5*. Between Case 1 and Case 2, and between Case 3 and Case 4, with similar development intensities (plot ratio: 2.13 vs. 2.29; 3.92 vs. 4.09), the different levels of planning and community management caused significant differences in many aspects. Meanwhile, between Case 1 and Case 4, and between Case 2 and Case 3, in spite of their sharply different development intensities (plot ratio: 2.13 vs. 4.09; 2.29 vs. 3.92), inappropriate planning and management resulted in similar liveability problems:

1. The satisfaction levels of *pedestrian walkways*, *internal motor roads* and *car/bike parking* of Case 2 and Case 3 were significantly higher than those of Case 1 and Case 4, which indicated that *the* ***pedestrian-vehicle-separated internal traffic system*** adopted by Case 2 and Case 3 indeed provided better residential environment than *the* ***mixed-pedestrian-vehicle internal traffic system*** of Case 1 and Case 4.

2. The satisfaction levels with *population density* of Case 2 and Case 3 were significantly higher than that of Case 1 and Case 4, which was inconsistent with their actual population density of Case 1 (**194** households per hectare), Case 2 (**184** households per hectare), Case 3 (**306** households per hectare) and Case 4 (**403** households per hectare). The result indicated that the residents' perception of population density within the high-rise housing estates could be influenced by many elements. Therefore, a Linear Regression Analysis based on *stepwise method*, the satisfaction with population density as dependent variable, and the satisfactions with the other 15 liveability elements as independent variables, was carried out to explore the related elements, and the outcome showed that the two elements: *green area and landscape*, and *building density and spacing*, were the key predictors. This provided an reasonable explanation: the high-quality landscape design and proper layout planning of Case 2 and Case 3 could effectively improve residents' satisfaction with population density, and vice versa.

3. *The* ***combination layout of slab and short-slab dwelling building*** and *the*

enclosure boundary of the mixed-use buildings of Case 2 formed a significantly better *wind environment* than the other three cases. Moreover, the great number of trees distributed in the gardens of Case 2 also played an important role. This result was consistent with the findings of field survey in *Chapter 5*.

4. Although Case 3 and Case 4 had similar development densities, their difference in the quality of planning, design and management produced significantly different outcomes in most aspects. On the whole, Case 3 constructed a much better housing estate than Case 4. Obviously, the central garden with high quality landscapes and rich leisure facilities in Case 3 provided an attractive internal public space, while the effective management and maintenance of the community enhanced the performance of the whole estate. On the contrary, the simple and rough landscape design of Case 4 deteriorated the outdoor environment, and the poor community management further destroyed the internal environment of the housing estate. Only two elements: ***building density and spacing***, and ***wind environment***, obtained relatively low satisfaction in both Case 3 and Case 4, which revealed the inherent defect of high-intensity high-rise housing estates consisting of short-slab and tower dwelling buildings.

5. Although Case 2 and Case 3 provided much better leisure facilities and places, Case 1 had the most satisfied *places for the elderly* among the 4 cases. According to the field survey, the main reason for this contradicting result could be that, the former was subject to charge, while the later was free despite of the lower quality standard, which reflected the importance of the affordability of the facilities on residents' satisfaction in using them.

Table 6- 13 Multiple Comparisons of the Mean Values of Satisfaction with the 16 Liveability Elements of Housing Estate

Multiple Comparisons							
Games-Howell							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Green Area and Landscape	Case 1	Case 2	-.345*	.126	.035	-.67	-.02
	Case 1	Case 3	-.253	.124	.181	-.58	.07
	Case 1	Case 4	.711*	.141	.000	.34	1.08
	Case 2	Case 3	.092	.110	.838	-.20	.38
	Case 2	Case 4	1.057*	.129	.000	.72	1.39
	Case 3	Case 4	.965*	.127	.000	.63	1.30
Play Areas for Children	Case 1	Case 2	.149	.133	.680	-.20	.50
	Case 1	Case 3	.235	.136	.317	-.12	.59
	Case 1	Case 4	1.445*	.139	.000	1.08	1.81
	Case 2	Case 3	.086	.139	.927	-.28	.45
	Case 2	Case 4	1.296*	.142	.000	.92	1.67
	Case 3	Case 4	1.211*	.145	.000	.83	1.59
Activity Places for the Elderly	Case 1	Case 2	.418*	.153	.038	.02	.82
	Case 1	Case 3	.618*	.149	.000	.23	1.01
	Case 1	Case 4	1.267*	.144	.000	.89	1.64
	Case 2	Case 3	.200	.166	.627	-.23	.63
	Case 2	Case 4	.849*	.162	.000	.43	1.27
	Case 3	Case 4	.649*	.158	.000	.24	1.06
Pedestrian Walkways	Case 1	Case 2	-.433*	.126	.005	-.76	-.10
	Case 1	Case 3	-.460*	.128	.003	-.80	-.12
	Case 1	Case 4	.276	.122	.116	-.04	.60
	Case 2	Case 3	-.028	.109	.994	-.31	.26
	Case 2	Case 4	.709*	.102	.000	.44	.97
	Case 3	Case 4	.737*	.104	.000	.47	1.01
Internal Motor Roads	Case 1	Case 2	-.561*	.131	.000	-.90	-.22
	Case 1	Case 3	-.498*	.150	.007	-.89	-.11
	Case 1	Case 4	-.042	.138	.990	-.40	.32
	Case 2	Case 3	.063	.126	.959	-.27	.39
	Case 2	Case 4	.519*	.111	.000	.23	.81
	Case 3	Case 4	.456*	.133	.005	.11	.80
Car/Bike Parking	Case 1	Case 2	-.613*	.168	.003	-1.05	-.17
	Case 1	Case 3	-.859*	.169	.000	-1.30	-.42
	Case 1	Case 4	-.105	.183	.940	-.58	.37
	Case 2	Case 3	-.247	.129	.229	-.58	.09
	Case 2	Case 4	.508*	.147	.004	.12	.89
	Case 3	Case 4	.754*	.148	.000	.37	1.14
Internal Public Service Facilities	Case 1	Case 2	.162	.131	.605	-.18	.50
	Case 1	Case 3	.212	.133	.386	-.13	.56
	Case 1	Case 4	1.352*	.139	.000	.99	1.72
	Case 2	Case 3	.050	.135	.983	-.30	.40
	Case 2	Case 4	1.190*	.142	.000	.82	1.56
	Case 3	Case 4	1.140*	.143	.000	.77	1.51
Population Density	Case 1	Case 2	-.415*	.106	.001	-.69	-.14
	Case 1	Case 3	-.291*	.110	.047	-.58	.00
	Case 1	Case 4	.218	.123	.295	-.10	.54
	Case 2	Case 3	.124	.079	.402	-.08	.33
	Case 2	Case 4	.633*	.097	.000	.38	.89
	Case 3	Case 4	.509*	.102	.000	.24	.77
Barrier-free Design	Case 1	Case 2	-.516*	.128	.001	-.85	-.18
	Case 1	Case 3	-.320	.144	.125	-.70	.06
	Case 1	Case 4	.084	.142	.935	-.29	.46
	Case 2	Case 3	.196	.111	.295	-.09	.49
	Case 2	Case 4	.600*	.109	.000	.32	.88
	Case 3	Case 4	.404*	.127	.010	.07	.74
Building Density and Spacing	Case 1	Case 2	-.010	.108	1.000	-.29	.27
	Case 1	Case 3	.246	.127	.217	-.09	.58
	Case 1	Case 4	.439*	.127	.004	.11	.77
	Case 2	Case 3	.256	.115	.124	-.04	.56
	Case 2	Case 4	.449*	.115	.001	.15	.75
	Case 3	Case 4	.193	.133	.471	-.15	.54

Outdoor Environment in Summer	Case 1	Case 2	-.044	.097	.969	-.30	.21
	Case 1	Case 3	.053	.107	.960	-.23	.33
	Case 1	***Case 4***	***.685****	***.124***	***.000***	***.36***	***1.01***
	Case 2	Case 3	.097	.098	.753	-.16	.35
	Case 2	***Case 4***	***.729****	***.116***	***.000***	***.42***	***1.03***
	Case 3	***Case 4***	***.632****	***.124***	***.000***	***.31***	***.96***
Outdoor Environment in Winter	Case 1	Case 2	-.050	.095	.954	-.30	.20
	Case 1	Case 3	.086	.098	.819	-.17	.34
	Case 1	***Case 4***	***.735****	***.100***	***.000***	***.47***	***.99***
	Case 2	Case 3	.135	.094	.480	-.11	.38
	Case 2	***Case 4***	***.784****	***.096***	***.000***	***.53***	***1.03***
	Case 3	***Case 4***	***.649****	***.099***	***.000***	***.39***	***.91***
Wind Environment	***Case 1***	***Case 2***	***-.463****	***.121***	***.001***	***-.78***	***-.15***
	Case 1	Case 3	-.059	.143	.976	-.43	.31
	Case 1	Case 4	.239	.122	.212	-.08	.56
	Case 2	***Case 3***	***.404****	***.127***	***.011***	***.07***	***.74***
	Case 2	***Case 4***	***.702****	***.104***	***.000***	***.43***	***.97***
	Case 3	Case 4	.298	.129	.101	-.04	.63
Maintenance and Management	Case 1	Case 2	.166	.134	.604	-.18	.52
	Case 1	Case 3	.015	.133	.999	-.33	.36
	Case 1	***Case 4***	***.682****	***.154***	***.000***	***.28***	***1.09***
	Case 2	Case 3	-.151	.132	.665	-.50	.19
	Case 2	***Case 4***	***.516****	***.153***	***.006***	***.12***	***.92***
	Case 3	***Case 4***	***.667****	***.153***	***.000***	***.27***	***1.07***
Community Security	Case 1	Case 2	.081	.155	.953	-.33	.49
	Case 1	Case 3	-.043	.156	.993	-.45	.37
	Case 1	***Case 4***	***.642****	***.171***	***.002***	***.19***	***1.09***
	Case 2	Case 3	-.124	.140	.813	-.49	.24
	Case 2	***Case 4***	***.560****	***.157***	***.003***	***.15***	***.97***
	Case 3	***Case 4***	***.684****	***.158***	***.000***	***.27***	***1.10***
Sense of Community	Case 1	Case 2	-.068	.109	.926	-.35	.22
	Case 1	Case 3	-.084	.113	.878	-.38	.21
	Case 1	***Case 4***	***.740****	***.130***	***.000***	***.40***	***1.08***
	Case 2	Case 3	-.017	.111	.999	-.31	.27
	Case 2	***Case 4***	***.808****	***.128***	***.000***	***.47***	***1.14***
	Case 3	***Case 4***	***.825****	***.131***	***.000***	***.48***	***1.17***
*. The mean difference is significant at the 0.05 level.							

As Figure 6-39 showed, due to the low satisfaction rates, ***car parking*** (26.5%), ***wind environment*** (30.6%), and ***internal motor roads*** (36.7%), were identified as the main liveability issues of Case 1. For Case 2, only one liveability element – ***activity places for the elderly*** (43.1%), obtained relatively low satisfaction rate of below 50%. The satisfaction rates of ***green areas and landscape*** (90.2%) and ***summer outdoor environment*** (90.2%) were higher than 90%.

According to the distribution of the satisfaction rates in Figure 6-40, the liveability problems of Case 3 were focused on the ***activity places for the elderly*** (31.6%), ***internal public service facilities*** (45.6%), and ***wind environment*** (45.6%). Only one element: ***green areas and landscape*** (80.7%) reached the satisfaction rate above 80%. The satisfaction rates of all of the 16 liveability elements of Case 4 were lower than 50%, within which five elements: ***internal public service facilities*** (7%), ***play areas for children*** (8.8%), ***activity places for the elderly*** (10.5%), ***outdoor environment in winter*** (12.3%), ***wind environment*** (14%) were below 15%. Over 60% of the respondents were dissatisfied with three elements: ***internal public service facilities*** (64.9%), ***play areas for children*** (63.2%) and ***activity places for the elderly*** (61.4%).

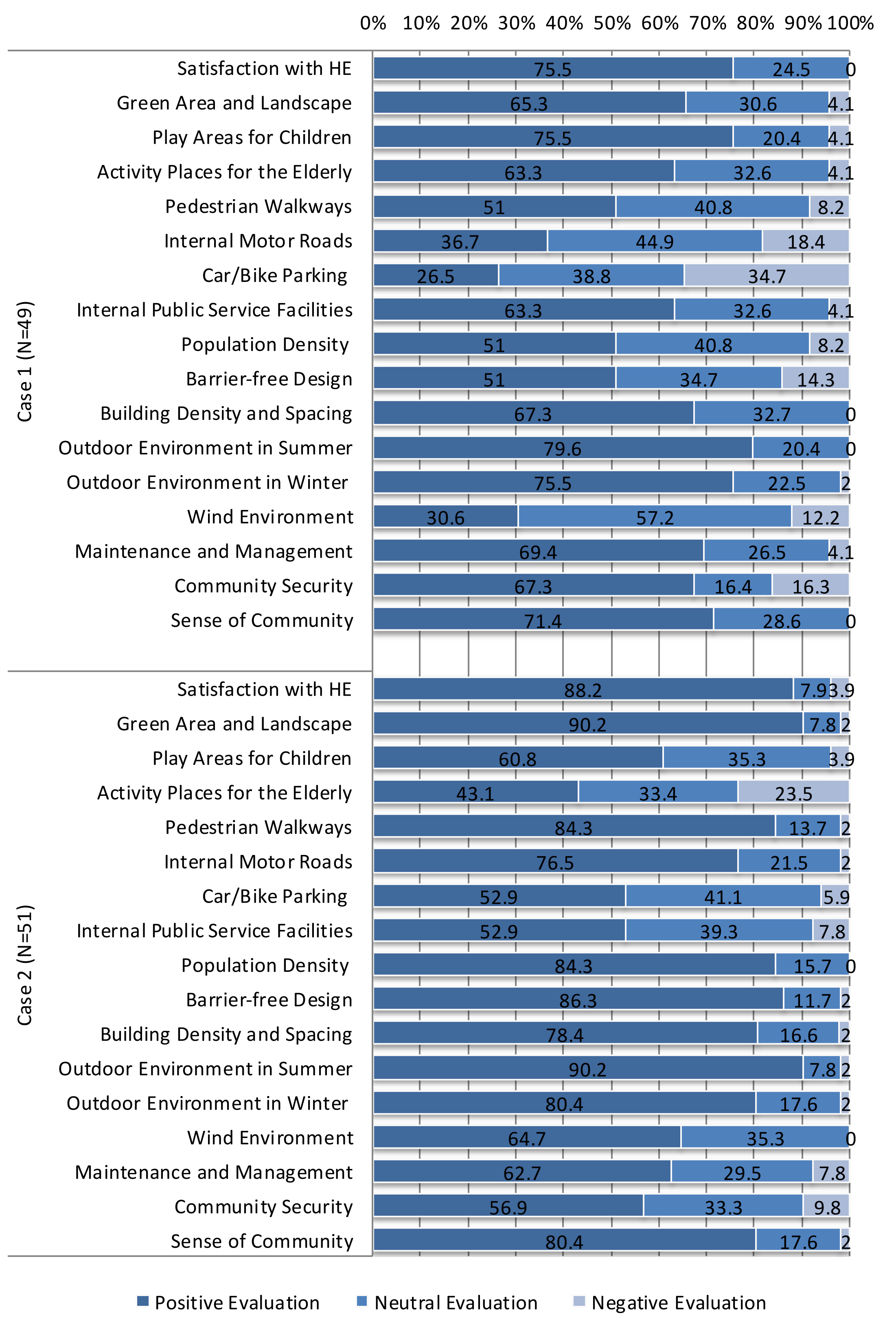


Figure 6- 39 Satisfaction Rates with the 16 Liveability Elements of Housing Estate (HE) in Case1 and Case 2

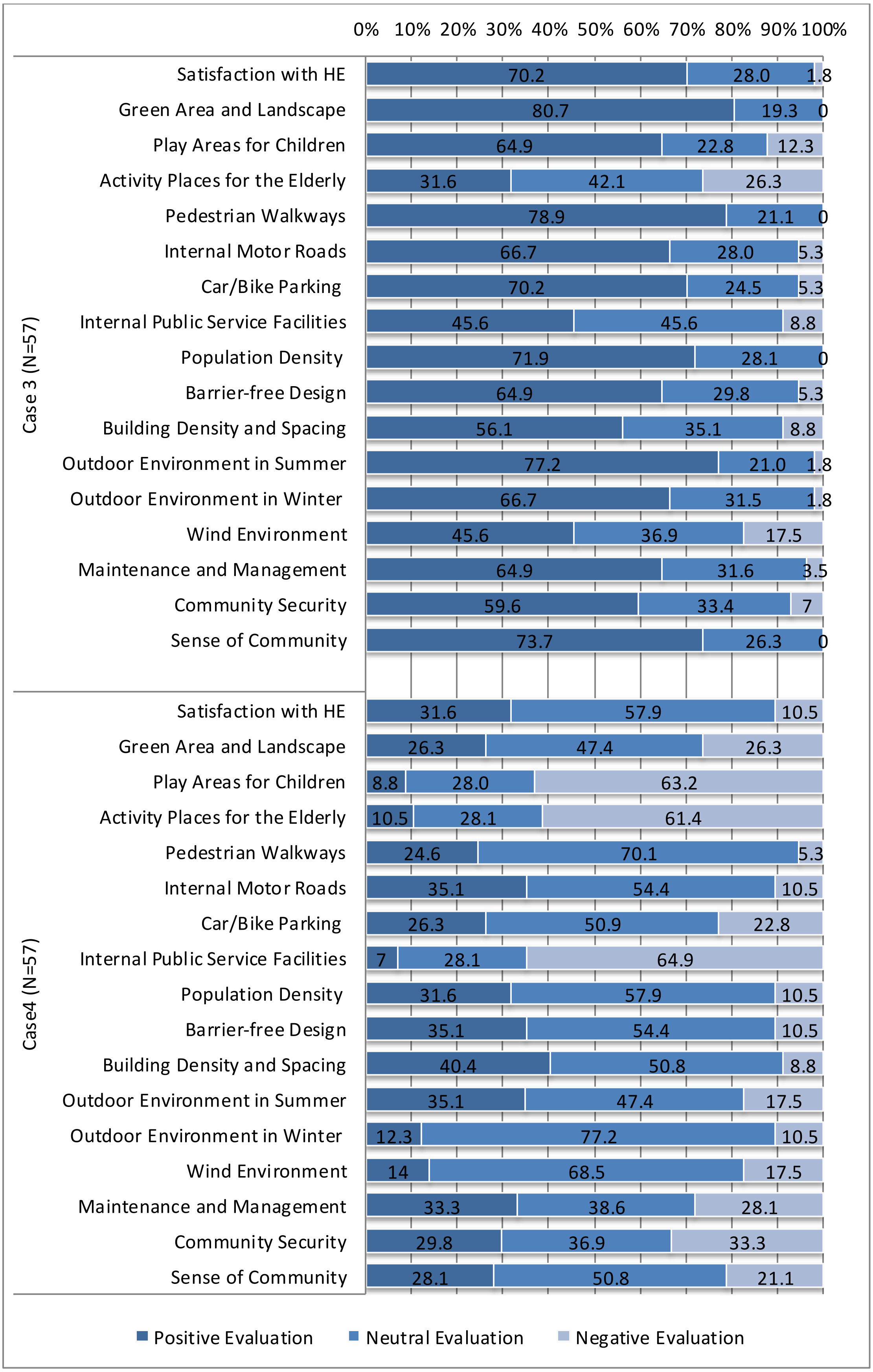


Figure 6- 40 Satisfaction Rates with the 16 Liveability Elements of Housing Estate (HE) in Case3 and Case 4

In summary, as Figure 6-41 showed, Case 2 (low intensity and good planning and management) reached a better comprehensive evaluation at the spatial level of housing estate, followed by Case 3 (high intensity and good planning and management), Case 1 (low intensity and basic planning and management) and Case 4 (high intensity and poor planning and management). This was consistent with the conclusion in *Section 5.7*: good planning, landscape design and community management could effectively moderate the negative effect of high development intensity. The ignorance of ***the demands of the elderly residents*** was one of the common liveability problems. The ***harsh wind environment*** within the clustered high-rise housing estates was widely complained by the residents. Due to the significantly higher population densities of Case 3 and Case 4, ***the internal public service facilities*** and ***play areas for children*** that were based on the old planning regulations could not meet the residents' needs.

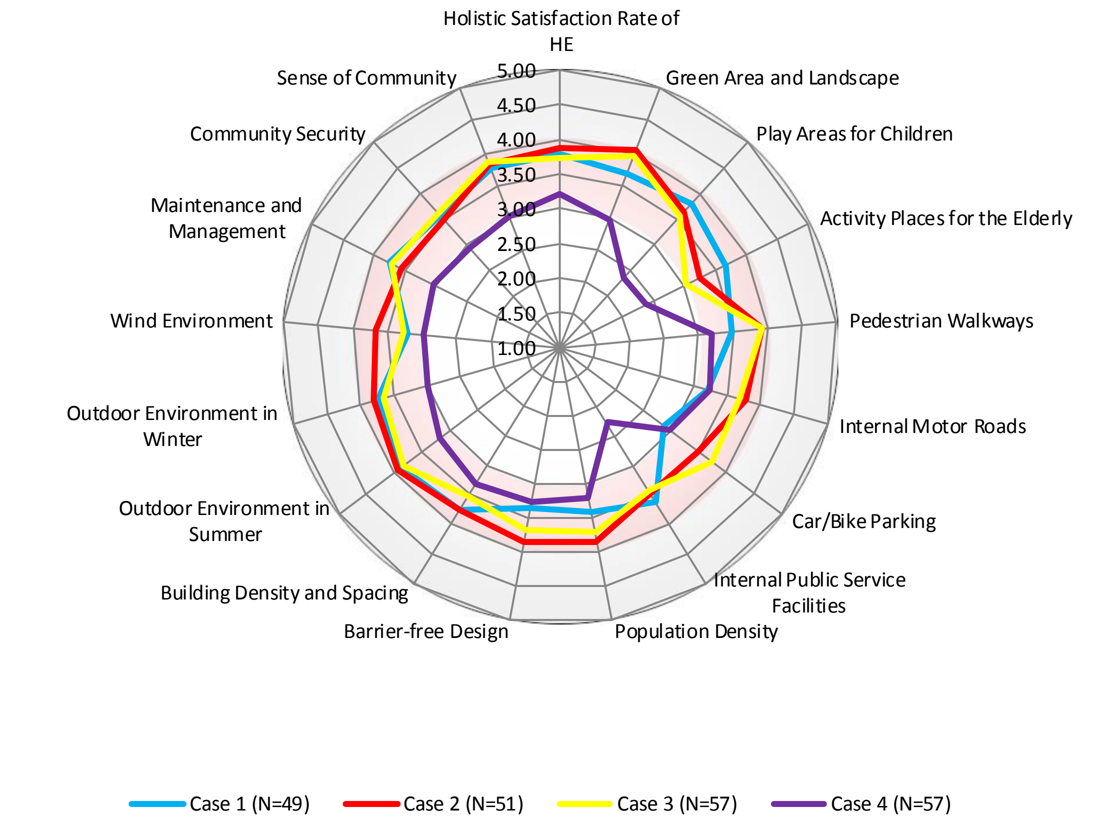


Figure 6-41 Radar Chart of the Satisfaction Level of Housing Estate (HE) and its 16 Liveability Elements

3. Dwelling building

At the spatial level of dwelling building, the study cases demonstrate a variety of mixture of three architectural forms: slab, short-slab and tower high-rise dwelling building. Correspondingly, the distributions of the respondents living in the different forms of dwelling buildings in the four cases are various (Table 6-14).

Table 6- 14 Sampling Distributions of the Respondents Living in Different Building Forms

Building Form	Case 1		Case 2		Case 3		Case 4	
	N	%	N	%	N	%	N	%
Slab high-rise dwelling building	43	87.8	38	74.5	0	0	0	0
Short-slab high-rise dwelling building	6	12.2	13	25.5	57	100	41	71.9
Tower high-rise dwelling building	0	0	0	0	0	0	16	28.1

The majority of the satisfaction ratings with the 16 liveability elements in Case 1, Case 2 and Case 3 ranged from 3.5 to 4.0 (Figure 6-42). In **Case 1**, *identity of building* (3.24), *barrier-free design* (3.27) and *facade design* (3.43) obtained relatively low satisfaction levels below 3.50, while *relation with neighbours* (3.88), *collection of domestic waste* (3.82) and *building height* (3.80) obtained high satisfaction levels. The dwelling buildings of **Case 2** demonstrated comprehensive and balanced performance due to high satisfaction levels of all 16 liveability elements ranging from 3.69 (*security in building*) to 3.98 (*collection of domestic waste*). The satisfaction levels of the majority of liveability elements in **Case 3** were higher than 3.5 except *identity of building* (3.46). Except *barrier-free design* (3.42) that was slightly better than Case 1, the satisfaction ratings of all other elements in **Case 4** were the lowest among the four study cases, especially in terms of *lift* (2.79), *security in building* (2.89), and *construction quality* (2.95) whose satisfaction ratings were below the medium value 3.

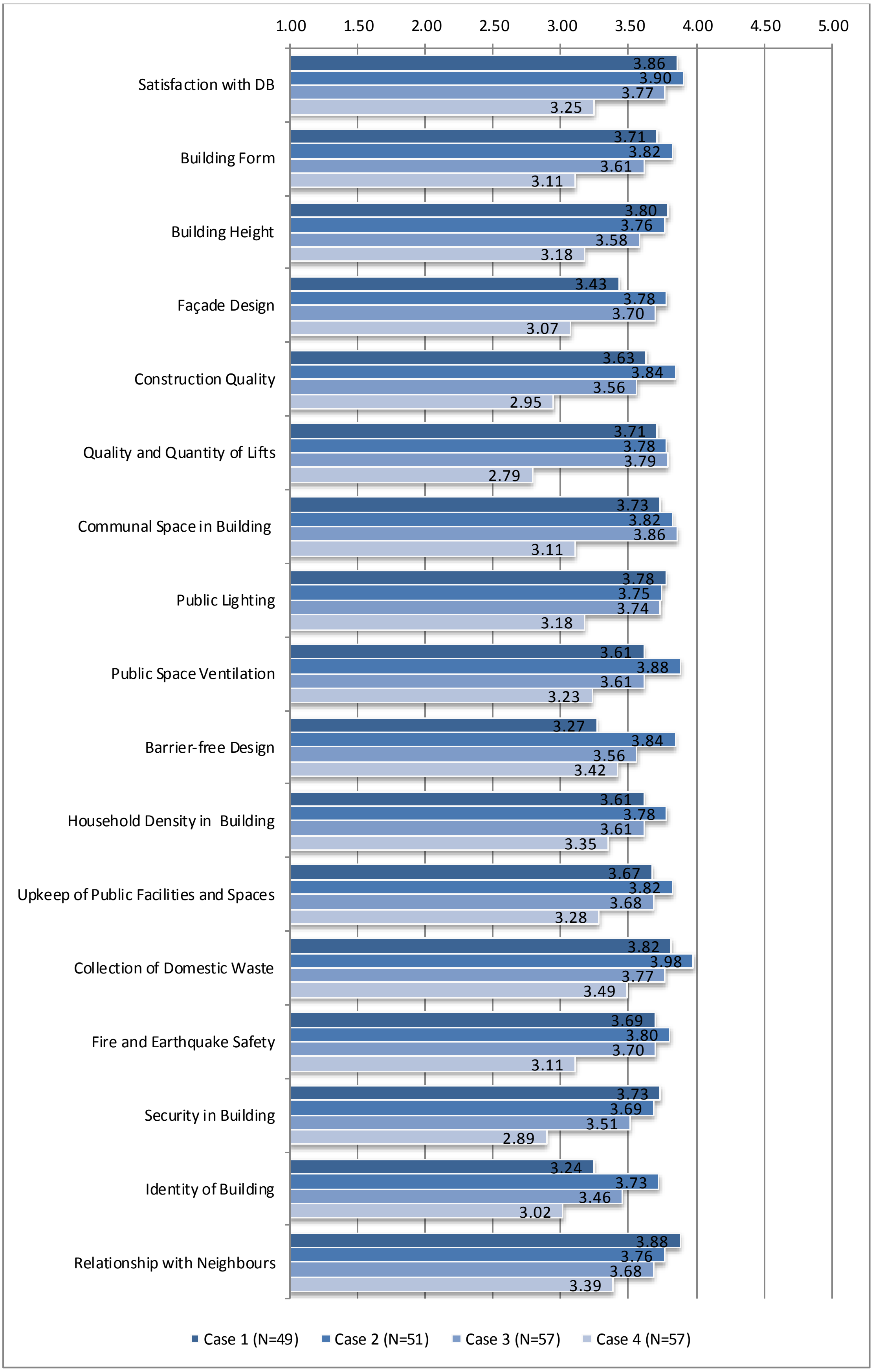


Figure 6- 42 Satisfaction Levels with the 16 Liveability Elements of Dwelling Building (DB) in the Four Study Cases

According to the outcomes of One-way ANOVA, in terms of most liveability elements, the satisfaction of Case 4 were significantly lower than those of the other three cases, while the differences among the three cases were not significant (Table 6-15).

Six liveability elements: *facade design*, *barrier-free design*, *household density within building*, *collection of domestic waste*, *identity of building* and *relations with neighbours*, showed complex evaluation results. Case 2 with mixed slab and short-slab high-rise buildings had significantly higher ratings than Case 1 and Case 4 in aspects of ***facade design, barrier-free design*** and ***identity of building***, but the differences between Case 2 and Case 3 on these aspects were not significant. Moreover, the satisfaction ratings with ***household density in dwelling building*** in Case 1, 3 and 4 were not significantly different in spite of the huge range from 18 to 192 households per dwelling building unit. Finally, satisfaction with ***collection of domestic waste*** and ***relations with neighbours*** of Case 3 were not significantly higher than those of Case 4. A probable explanation could be the similarity in high household density within the buildings (Case 3: 75 to 112 households per building unit, Case 4: 54 to 192 households per building unit).

Table 6- 15 Multiple Comparisons of the Mean Values of Satisfaction with the 16 Liveability Elements of Dwelling Building

Multiple Comparisons							
Games-Howell							
Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Building Form	Case 1	Case 2	-.109	.117	.787	-.42	.20
	Case 1	Case 3	.100	.117	.828	-.21	.41
	Case 1	***Case 4***	***.609****	***.130***	***.000***	***.27***	***.95***
	Case 2	Case 3	.209	.110	.234	-.08	.50
	Case 2	***Case 4***	***.718****	***.123***	***.000***	***.40***	***1.04***
	Case 3	***Case 4***	***.509****	***.124***	***.000***	***.19***	***.83***
Building Height	Case 1	Case 2	.031	.116	.993	-.27	.33
	Case 1	Case 3	.217	.106	.180	-.06	.49
	Case 1	***Case 4***	***.620****	***.118***	***.000***	***.31***	***.93***
	Case 2	Case 3	.186	.121	.417	-.13	.50
	Case 2	***Case 4***	***.589****	***.131***	***.000***	***.25***	***.93***
	Case 3	***Case 4***	***.404****	***.123***	***.007***	***.08***	***.72***
Façade Design	***Case 1***	***Case 2***	***-.356****	***.135***	***.047***	***-.71***	***.00***
	Case 1	Case 3	-.273	.131	.167	-.62	.07
	Case 1	***Case 4***	***.358****	***.126***	***.028***	***.03***	***.69***
	Case 2	Case 3	.083	.136	.929	-.27	.44
	Case 2	***Case 4***	***.714****	***.131***	***.000***	***.37***	***1.06***
	Case 3	***Case 4***	***.632****	***.127***	***.000***	***.30***	***.96***
Construction Quality	Case 1	Case 2	-.210	.104	.188	-.48	.06
	Case 1	Case 3	.071	.132	.949	-.27	.42
	Case 1	***Case 4***	***.685****	***.131***	***.000***	***.34***	***1.03***
	Case 2	Case 3	.282	.116	.079	-.02	.59
	Case 2	***Case 4***	***.896****	***.114***	***.000***	***.60***	***1.20***
	Case 3	***Case 4***	***.614****	***.140***	***.000***	***.25***	***.98***
Quality and Quantity of Lifts	Case 1	Case 2	-.070	.129	.948	-.41	.27
	Case 1	Case 3	-.075	.127	.934	-.41	.26
	Case 1	***Case 4***	***.925****	***.158***	***.000***	***.51***	***1.34***
	Case 2	Case 3	-.005	.118	1.000	-.31	.30
	Case 2	***Case 4***	***.995****	***.151***	***.000***	***.60***	***1.39***
	Case 3	***Case 4***	***1.000****	***.149***	***.000***	***.61***	***1.39***
Communal Space in Building	Case 1	Case 2	-.089	.093	.774	-.33	.15
	Case 1	Case 3	-.125	.101	.605	-.39	.14
	Case 1	***Case 4***	***.629****	***.126***	***.000***	***.30***	***.96***
	Case 2	Case 3	-.036	.095	.981	-.28	.21
	Case 2	***Case 4***	***.718****	***.122***	***.000***	***.40***	***1.04***
	Case 3	***Case 4***	***.754****	***.128***	***.000***	***.42***	***1.09***
Public Lighting	Case 1	Case 2	.030	.100	.990	-.23	.29
	Case 1	Case 3	.039	.116	.987	-.26	.34
	Case 1	***Case 4***	***.600****	***.135***	***.000***	***.25***	***.95***
	Case 2	Case 3	.008	.105	1.000	-.27	.28
	Case 2	***Case 4***	***.570****	***.126***	***.000***	***.24***	***.90***
	Case 3	***Case 4***	***.561****	***.139***	***.001***	***.20***	***.92***
Public Space Ventilation	Case 1	Case 2	-.270	.116	.101	-.57	.03
	Case 1	Case 3	-.002	.133	1.000	-.35	.34
	Case 1	***Case 4***	***.384****	***.133***	***.024***	***.04***	***.73***
	Case 2	Case 3	.268	.120	.122	-.05	.58
	Case 2	***Case 4***	***.654****	***.121***	***.000***	***.34***	***.97***
	Case 3	***Case 4***	***.386****	***.137***	***.028***	***.03***	***.74***
Barrier-free Design	***Case 1***	***Case 2***	***-.578****	***.155***	***.002***	***-.98***	***-.17***
	Case 1	Case 3	-.296	.170	.308	-.74	.15
	Case 1	Case 4	-.156	.148	.720	-.54	.23
	Case 2	Case 3	.282	.151	.248	-.11	.68
	Case 2	***Case 4***	***.422****	***.126***	***.006***	***.09***	***.75***
	Case 3	Case 4	.140	.144	.763	-.24	.52
Household Density in Building	Case 1	Case 2	-.172	.112	.419	-.47	.12
	Case 1	Case 3	-.002	.125	1.000	-.33	.33
	Case 1	Case 4	.261	.130	.189	-.08	.60
	Case 2	Case 3	.170	.107	.391	-.11	.45
	Case 2	***Case 4***	***.433****	***.112***	***.001***	***.14***	***.73***
	Case 3	Case 4	.263	.126	.162	-.06	.59

Upkeep of Public Facilities and Spaces	Case 1	Case 2	-.150	.119	.588	-.46	.16
	Case 1	Case 3	-.011	.133	1.000	-.36	.34
	Case 1	***Case 4***	***.393****	***.132***	***.019***	***.05***	***.74***
	Case 2	Case 3	.139	.119	.646	-.17	.45
	Case 2	***Case 4***	***.543****	***.118***	***.000***	***.24***	***.85***
	Case 3	***Case 4***	***.404****	***.132***	***.015***	***.06***	***.75***
Collection of Domestic Waste	Case 1	Case 2	-.164	.104	.397	-.44	.11
	Case 1	Case 3	.044	.116	.981	-.26	.35
	Case 1	***Case 4***	***.325****	***.113***	***.026***	***.03***	***.62***
	Case 2	Case 3	.208	.106	.207	-.07	.48
	Case 2	***Case 4***	***.489****	***.103***	***.000***	***.22***	***.76***
	Case 3	Case 4	.281	.115	.076	-.02	.58
Fire and Earthquake Safety	Case 1	Case 2	-.130	.117	.680	-.44	.18
	Case 1	Case 3	-.028	.116	.995	-.33	.28
	Case 1	***Case 4***	***.568****	***.148***	***.001***	***.18***	***.96***
	Case 2	Case 3	.102	.088	.649	-.13	.33
	Case 2	***Case 4***	***.699****	***.128***	***.000***	***.36***	***1.03***
	Case 3	***Case 4***	***.596****	***.127***	***.000***	***.26***	***.93***
Security in Building	Case 1	Case 2	.048	.150	.988	-.35	.44
	Case 1	Case 3	.226	.163	.509	-.20	.65
	Case 1	***Case 4***	***.840****	***.168***	***.000***	***.40***	***1.28***
	Case 2	Case 3	.178	.137	.568	-.18	.54
	Case 2	***Case 4***	***.792****	***.143***	***.000***	***.42***	***1.16***
	Case 3	***Case 4***	***.614****	***.156***	***.001***	***.21***	***1.02***
Identity of Building	***Case 1***	***Case 2***	***-.481****	***.110***	***.000***	***-.77***	***-.19***
	Case 1	Case 3	-.211	.129	.364	-.55	.13
	Case 1	Case 4	.227	.125	.273	-.10	.55
	Case 2	Case 3	.269	.119	.115	-.04	.58
	Case 2	***Case 4***	***.708****	***.115***	***.000***	***.41***	***1.01***
	Case 3	***Case 4***	***.439****	***.134***	***.007***	***.09***	***.79***
Relationship with Neighbours	Case 1	Case 2	.113	.112	.743	-.18	.40
	Case 1	Case 3	.193	.113	.326	-.10	.49
	Case 1	***Case 4***	***.492****	***.118***	***.000***	***.18***	***.80***
	Case 2	Case 3	.080	.111	.887	-.21	.37
	Case 2	***Case 4***	***.379****	***.115***	***.008***	***.08***	***.68***
	Case 3	Case 4	.298	.117	.059	-.01	.60

*. The mean difference is significant at the 0.05 level.

Furthermore, a series of One-way ANOVA were carried out to compare the satisfaction ratings of the respondents who lived in slab, short-slab and tower dwelling buildings in respective study cases. In Case 1 and Case 2, the levels of satisfaction with the 16 liveability elements were not significantly different between the residents of slab and short-slab housings. Similarly, in Case 4, the difference between short-slab and tower housing was not significant. It is concluded that, ***within one high-rise housing estate, the building form of high-rise dwelling had no significant impact on their liveability evaluations***.

In terms of satisfaction rate, ***identity of building*** (28.6%), ***barrier-free design*** (44.9%) and ***facade design*** (46.9%) were found to be the main liveability problems of **Case 1** due to their relatively low satisfaction rates below 60%. *Collection of domestic waste* (81.6%) was the only element whose satisfaction rate was over 80%. It is worth noting that two elements: ***barrier-free design*** (16.3%) and ***security in building***

(10.2%) both had dissatisfaction rates over 10%（Figure 6-43, Top）.

The dwelling buildings of **Case 2** did not have serious shortcomings (Figure 6-43, Bottom). The lowest satisfaction rate was found on ***security in dwelling building*** (64.7%), which was still above 60%. Five of the elements: collection of domestic waste (92.2%), communal spaces in dwelling building (84.3%), public space ventilation (84.3%), construction quality (82.4%) and upkeep of public facilities (80.4%) obtained high satisfaction rates over 80%. All of the dissatisfaction rates of the 16 elements were lower than 5%.

For **Case 3**, the satisfaction rates of ***building identity*** (49.1%), ***construction quality*** (54.4%) and ***security in building*** (59.6%) were lower than 60%, while none of the satisfaction rates was higher than 80% (Figure 6-44, Top). Meanwhile, 14% of the respondents were dissatisfied with ***barrier-free design*** and ***security in building***, which were the same problems identified in Case 1.

The satisfaction rates of all of the 16 liveability elements in **Case 4** were below 60% (Figure 6-44, Bottom). Six elements: ***construction quality*** (22.8%), ***facade design*** (24.6%), ***building identity*** (24.6%), ***security in building*** (24.6%), ***lift*** (28.1%) and ***building form*** (29.8%) had satisfaction rates lower than 30%. Furthermore, 6 out of 16 liveability elements obtained dissatisfaction rates above 20%, and among them, 42.1% of the respondents in Case 4 were dissatisfied with ***the quality and quantity of lifts***.

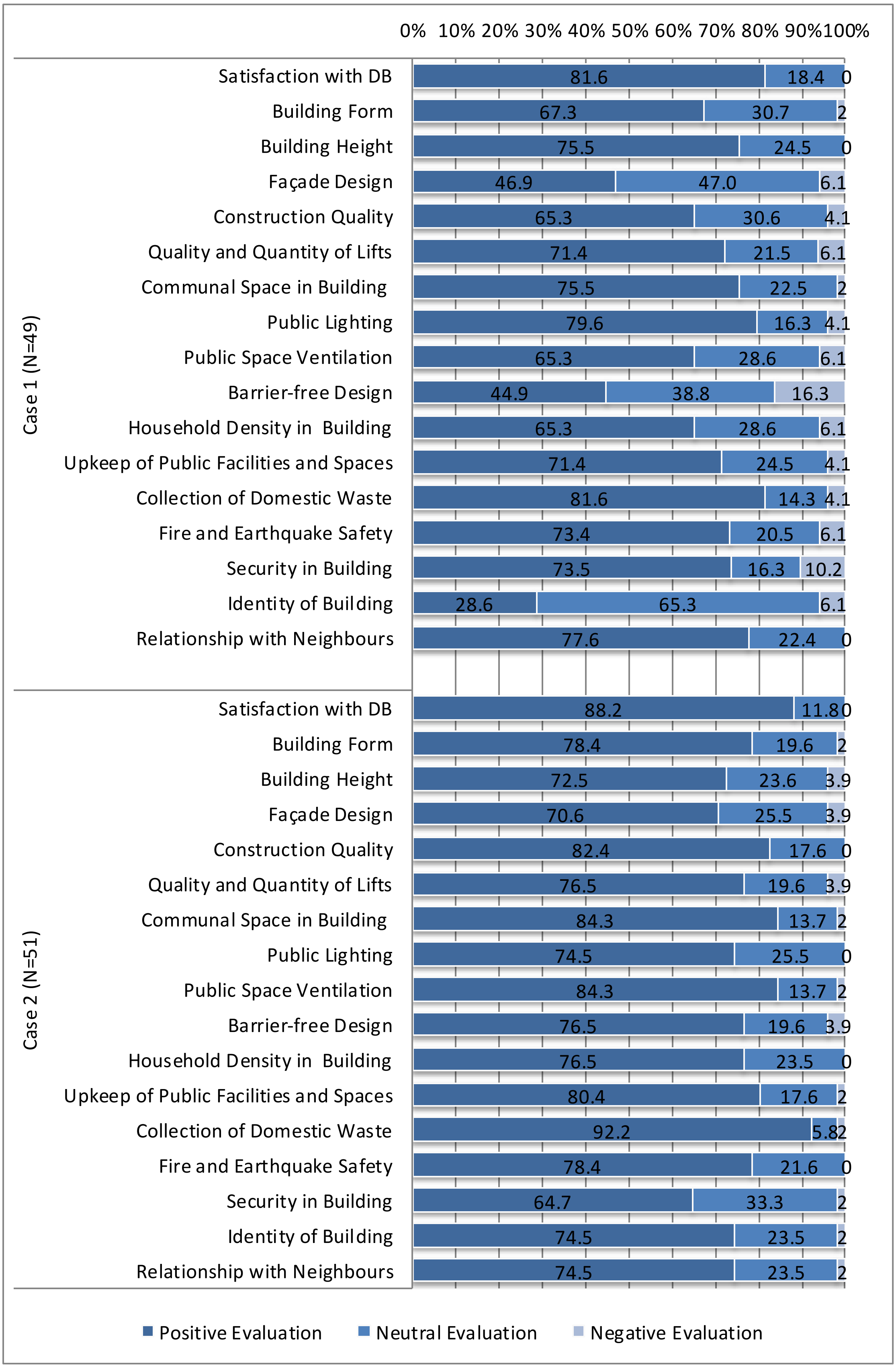


Figure 6- 43 Satisfaction Rates with the 16 Liveability Elements of Dwelling Building (DB) in Case 1 and Case 2

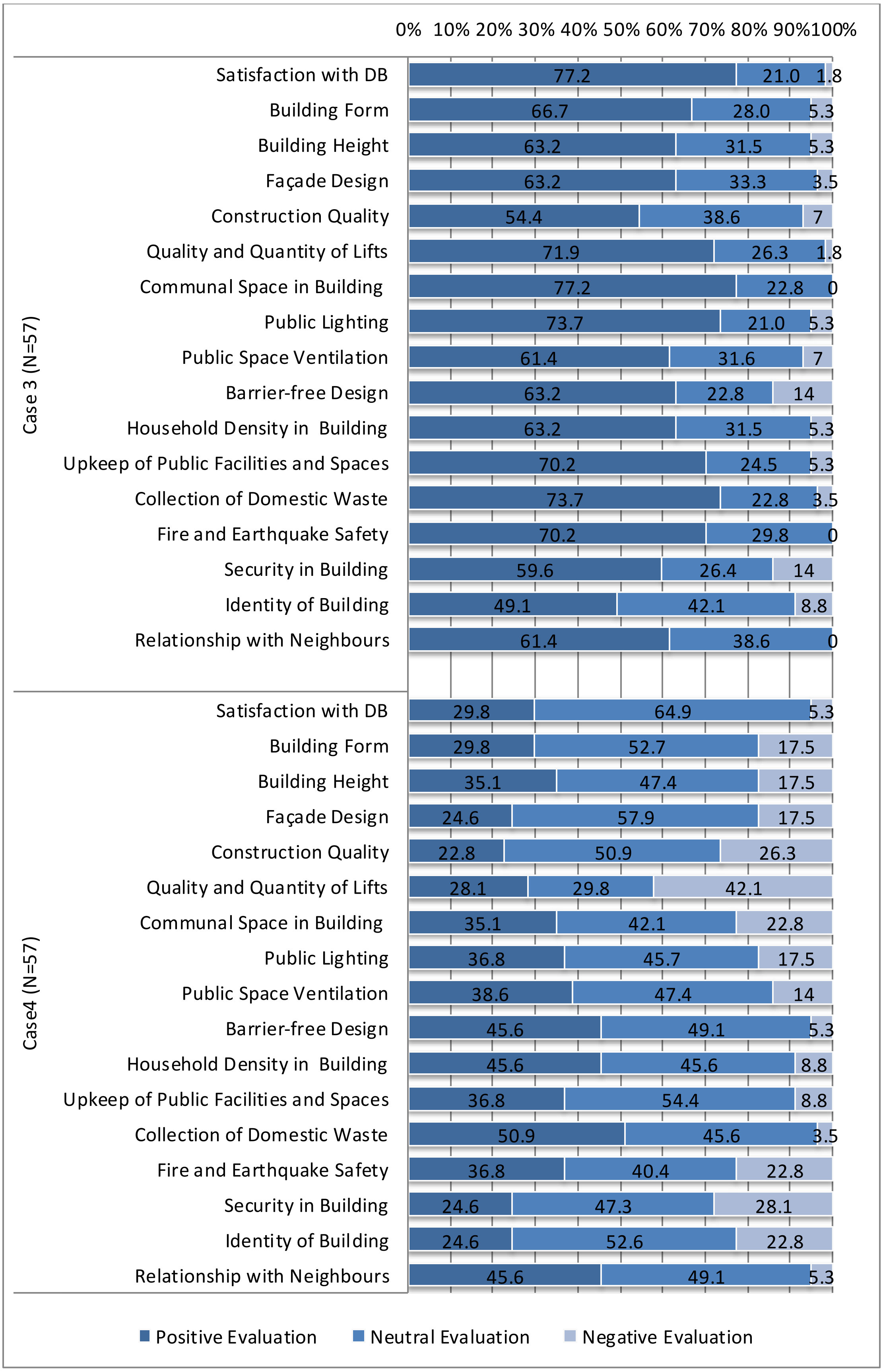


Figure 6- 44 Satisfaction Rates with the 16 Liveability Elements of Dwelling Building (DB) in Case 3 and Case 4

To sum up, as the Figure 6-45 showed, Case 2 achieved the best comprehensive performance at the spatial level of dwelling building, and Case 4 was the worst. Consistent with the conclusion in *Section 5.7*, the different architecture designs and building forms in the four study cases were considered to be the reason behind the distinctive liveability problems. For example, the ignorance of the barrier-free design in Case 1 and Case 3 were complained by the respondents and the significantly higher household density of the tower dwelling buildings in Case 4 resulted in the dissatisfaction with the quality and quantity of lifts. ***Building identity*** and ***facade design*** were identified as the main common liveability issues in all cases. For the housing estates with high intensities (Case 3 and 4), ***construction quality*** was less satisfactory compared with earlier low-density developments.

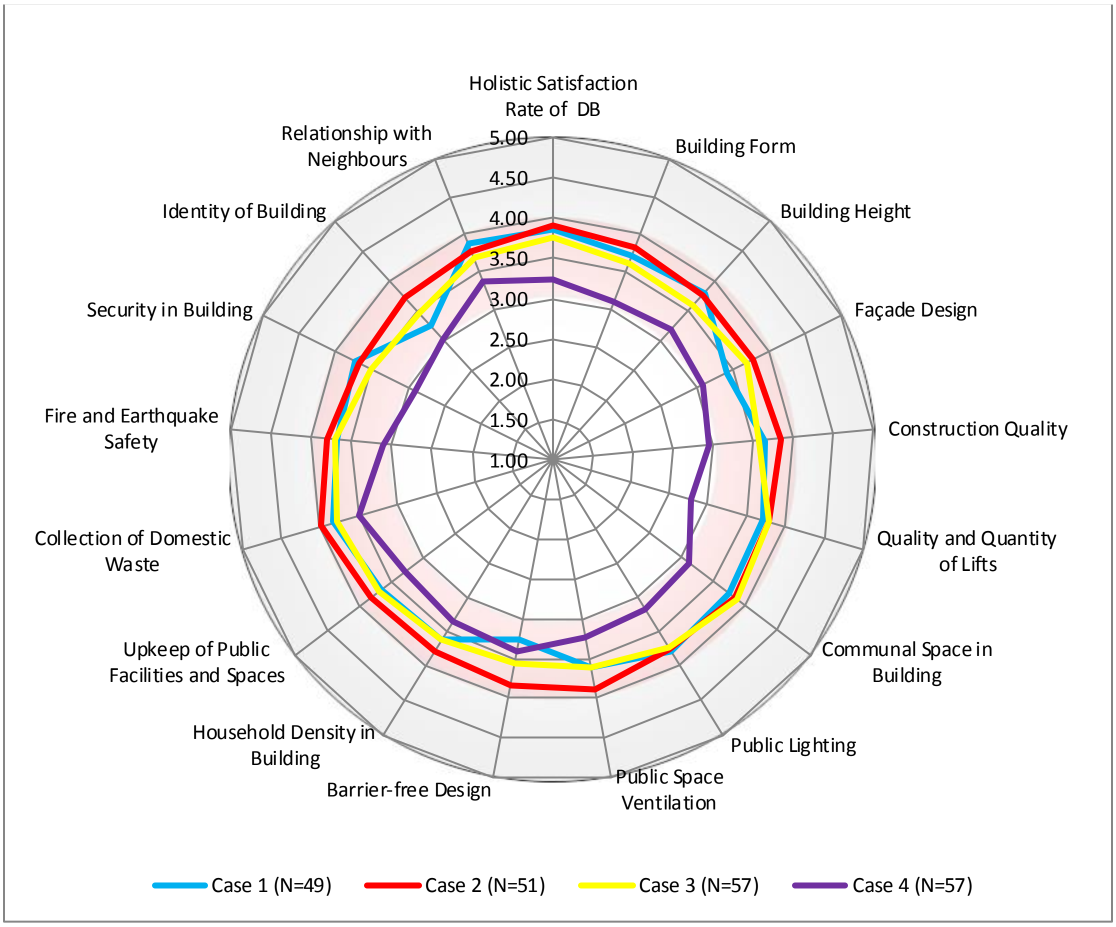


Figure 6- 45 Radar Chart of the Satisfaction Level of Dwelling Building (DB) and its 16 Liveability Elements

4. Dwelling unit

At the spatial level of dwelling unit, the 4 research cases have different distributions of dwelling units with various sizes, orientations and ventilation profiles as analysed in *Chapter 5* (See Table 5-2). Case 1, as the representative of early high-rise housing estates in Tianjin, consisted of mostly comfortable dwelling units; Case 2, as the exploration and experiment of the high-rise housing estates with mixed slab and short-slab dwelling buildings, comprised of more north-south-oriented dwelling units without cross-ventilation; Case 3, as a typical high-rise housing development with mature real estate management, achieved a balance between size and comfort of dwelling units with standardized designs; Case 4, as a sample of high-rise housing estates pursuing high development intensity and short-term profit, focused on providing small dwelling units with high density that are easy to sell due to their lower property prices.

On the whole, the performance of Case 4 on the 18 liveability elements on the spatial level of dwelling unit was the least satisfactory among the four study cases (Figure 6-46). The satisfaction levels of ***housing cost*** (2.4), ***internal sound-proof*** (2.72), ***storage space*** (2.79), ***external sound-proof*** (2.81) and ***private outdoor space*** (2.95) were lower than the medium value 3.0. Only 4 elements: ***infrastructure*** (3.63), ***natural lighting*** (3.6), ***indoor heating*** (3.6) and ***perceived comfort*** (3.51), achieved satisfaction ratings above 3.5.

In Case 1, the satisfaction levels of six liveability elements were located in the interval between 3.0 and 3.5, which were ***storage*** (3.22), ***internal sound-proof*** (3.24), ***external sound-proof*** (3.33), ***property cost*** (3.39), ***structure quality*** (3.43) and ***private outdoor space*** (3.43). The satisfaction ratings of ***indoor natural lighting*** (4.06), ***natural ventilation*** (4.02) and ***heating*** (4.22) were above 4.0, which reflected good comfort of the dwelling units located in slab high-rise housing estates.

The majority of the satisfaction ratings of Case 2 were distributed in the interval between 3.5 and 4.0, and only three elements: ***property cost*** (3.33), ***internal sound-proof*** (3.37) and ***external sound-proof*** (3.47) obtained relatively low satisfaction levels.

In Case 3, ***storage*** (3.04), ***internal sound-proof*** (3.07), ***property cost*** (3.14), ***private outdoor space*** (3.25), ***external outdoor sound-proof*** (3.35) and ***structure quality*** (3.39) had satisfaction levels below 3.5.

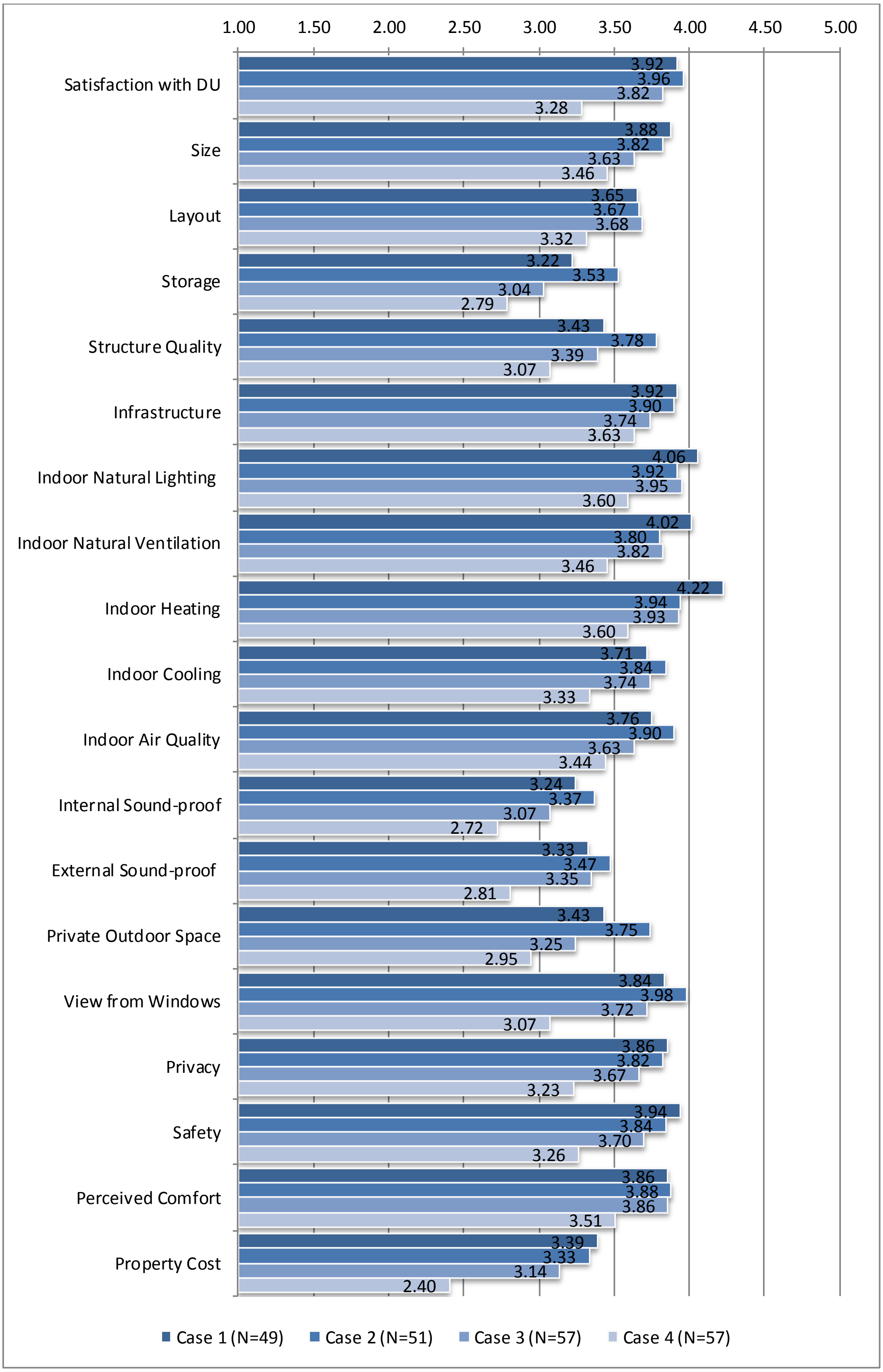


Figure 6- 46 the Four Study Cases' Satisfaction Levels with the 18 Liveability Elements of Dwelling Unit (DU)

One-way ANOVA was conducted to compare the satisfaction ratings of the 18 liveability elements among the 4 cases. The results in Table 6-16 indicated that Case 4 obtained significantly lower satisfaction with most elements, compared to the other three cases. Due to the similar building forms of Case 3 and Case 4, the differences of the satisfaction with *size*, *storage*, *structure quality*, *infrastructure, indoor natural ventilation*, *indoor heating*, *indoor air quality* and *internal sound-proof* were not significant. Between Case 2 and Case 4, the satisfaction ratings of only two elements (*infrastructure* and *indoor heating*) were not significantly different. Satisfaction with *layout*, *structure quality*, *storage* and *infrastructure* of Case 1 were not significantly higher than those of Case 4. Comparing Case 1 and Case 2, the former's satisfaction with *structure quality* was significantly lower than the latter's, which was the only significant difference between them. Between Case 1 and Case 3, none of the satisfaction ratings was significantly different. Finally, 4 elements: *storage*, *structure quality*, *indoor air quality* and *private outdoor space* had significantly higher satisfaction ratings in Case 2 than in Case 3.

In summary, the fundamental life support facilities including ***infrastructure*** and ***urban central heating system*** achieved high satisfaction in all of study cases. Among Case 1, Case 2 and Case 3, the majority of liveability elements of dwelling units had similar performances. The *structure quality* of Case 2 was given significantly higher satisfaction than the other cases. The comprehensive satisfaction level of Case 4 was significantly lower than the other three cases.

Table 6-16 Multiple Comparisons of Means of Satisfactions with the 18 Liveability Elements of Dwelling Unit

Multiple Comparisons

Games-Howell

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Size	Case 1	Case 2	.054	.104	.955	-.22	.33
	Case 1	Case 3	.246	.124	.202	-.08	.57
	Case 1	***Case 4***	***.421****	***.125***	***.006***	***.09***	***.75***
	Case 2	Case 3	.192	.123	.404	-.13	.51
	Case 2	***Case 4***	***.367****	***.124***	***.019***	***.04***	***.69***
	Case 3	Case 4	.175	.141	.600	-.19	.54
Layout	Case 1	Case 2	-.014	.123	1.000	-.33	.31
	Case 1	Case 3	-.031	.125	.994	-.36	.30
	Case 1	Case 4	.337	.146	.101	-.04	.72
	Case 2	Case 3	-.018	.105	.998	-.29	.26
	Case 2	***Case 4***	***.351****	***.129***	***.038***	***.01***	***.69***
	Case 3	***Case 4***	***.368****	***.131***	***.029***	***.03***	***.71***
Storage	Case 1	Case 2	-.305	.154	.202	-.71	.10
	Case 1	Case 3	.189	.167	.671	-.25	.63
	Case 1	Case 4	.435	.178	.075	-.03	.90
	Case 2	***Case 3***	***.494****	***.144***	***.005***	***.12***	***.87***
	Case 2	***Case 4***	***.740****	***.156***	***.000***	***.33***	***1.15***
	Case 3	Case 4	.246	.169	.470	-.20	.69
Structure Quality	***Case 1***	***Case 2***	***-.356****	***.126***	***.030***	***-.69***	***-.03***
	Case 1	Case 3	.043	.137	.990	-.32	.40
	Case 1	Case 4	.358	.159	.114	-.06	.77
	Case 2	***Case 3***	***.398****	***.120***	***.007***	***.09***	***.71***
	Case 2	***Case 4***	***.714****	***.144***	***.000***	***.34***	***1.09***
	Case 3	Case 4	.316	.154	.174	-.09	.72
Infrastructure	Case 1	Case 2	.016	.122	.999	-.30	.33
	Case 1	Case 3	.182	.119	.425	-.13	.49
	Case 1	Case 4	.287	.116	.072	-.02	.59
	Case 2	Case 3	.165	.118	.500	-.14	.47
	Case 2	Case 4	.270	.115	.095	-.03	.57
	Case 3	Case 4	.105	.112	.785	-.19	.40
Indoor Natural Lighting	Case 1	Case 2	.140	.101	.512	-.12	.40
	Case 1	Case 3	.114	.120	.777	-.20	.43
	Case 1	***Case 4***	***.465****	***.128***	***.003***	***.13***	***.80***
	Case 2	Case 3	-.026	.101	.994	-.29	.24
	Case 2	***Case 4***	***.325****	***.111***	***.022***	***.03***	***.62***
	Case 3	***Case 4***	***.351****	***.128***	***.036***	***.02***	***.69***
Indoor Natural Ventilation	Case 1	Case 2	.216	.116	.249	-.09	.52
	Case 1	Case 3	.196	.131	.443	-.15	.54
	Case 1	***Case 4***	***.564****	***.126***	***.000***	***.24***	***.89***
	Case 2	Case 3	-.021	.133	.999	-.37	.33
	Case 2	***Case 4***	***.348****	***.129***	***.039***	***.01***	***.68***
	Case 3	Case 4	.368	.142	.052	.00	.74
Indoor Heating	Case 1	Case 2	.283	.123	.104	-.04	.60
	Case 1	Case 3	.295	.117	.062	-.01	.60
	Case 1	***Case 4***	***.628****	***.129***	***.000***	***.29***	***.97***
	Case 2	Case 3	.011	.128	1.000	-.32	.35
	Case 2	Case 4	.345	.140	.071	-.02	.71
	Case 3	Case 4	.333	.134	.068	-.02	.68
Indoor Cooling	Case 1	Case 2	-.129	.109	.637	-.41	.16
	Case 1	Case 3	-.023	.110	.997	-.31	.27
	Case 1	***Case 4***	***.381****	***.123***	***.013***	***.06***	***.70***
	Case 2	Case 3	.106	.102	.723	-.16	.37
	Case 2	***Case 4***	***.510****	***.116***	***.000***	***.21***	***.81***
	Case 3	***Case 4***	***.404****	***.117***	***.004***	***.10***	***.71***
Indoor Air Quality	Case 1	Case 2	-.147	.107	.520	-.43	.13
	Case 1	Case 3	.124	.119	.727	-.19	.43
	Case 1	***Case 4***	***.317****	***.120***	***.047***	***.00***	***.63***
	Case 2	***Case 3***	***.270****	***.097***	***.031***	***.02***	***.52***
	Case 2	***Case 4***	***.463****	***.098***	***.000***	***.21***	***.72***
	Case 3	Case 4	.193	.111	.308	-.10	.48

Internal Sound-proof	Case 1	Case 2	-.128	.161	.858	-.55	.29
	Case 1	Case 3	.175	.162	.704	-.25	.60
	Case 1	***Case 4***	***.526****	***.173***	***.016***	***.07***	***.98***
	Case 2	Case 3	.302	.144	.160	-.07	.68
	Case 2	***Case 4***	***.653****	***.156***	***.000***	***.25***	***1.06***
	Case 3	Case 4	.351	.158	.122	-.06	.76
External Sound-proof	Case 1	Case 2	-.144	.146	.756	-.53	.24
	Case 1	Case 3	-.024	.159	.999	-.44	.39
	Case 1	***Case 4***	***.520****	***.161***	***.009***	***.10***	***.94***
	Case 2	Case 3	.120	.143	.835	-.25	.49
	Case 2	***Case 4***	***.664****	***.145***	***.000***	***.29***	***1.04***
	Case 3	***Case 4***	***.544****	***.158***	***.005***	***.13***	***.96***
Private Outdoor Space	Case 1	Case 2	-.317	.140	.116	-.68	.05
	Case 1	Case 3	.183	.154	.634	-.22	.58
	Case 1	***Case 4***	***.481****	***.150***	***.009***	***.09***	***.87***
	Case 2	***Case 3***	***.499****	***.133***	***.002***	***.15***	***.85***
	Case 2	***Case 4***	***.798****	***.129***	***.000***	***.46***	***1.13***
	Case 3	***Case 4***	***.298***	***.143***	***.165***	***-.08***	***.67***
View from Windows	Case 1	Case 2	-.144	.085	.338	-.37	.08
	Case 1	Case 3	.117	.112	.721	-.18	.41
	Case 1	***Case 4***	***.767****	***.120***	***.000***	***.45***	***1.08***
	Case 2	Case 3	.261	.104	.064	-.01	.53
	Case 2	***Case 4***	***.910****	***.113***	***.000***	***.62***	***1.21***
	Case 3	***Case 4***	***.649****	***.134***	***.000***	***.30***	***1.00***
Privacy	Case 1	Case 2	.034	.089	.982	-.20	.27
	Case 1	Case 3	.190	.105	.270	-.08	.46
	Case 1	***Case 4***	***.629****	***.120***	***.000***	***.31***	***.94***
	Case 2	Case 3	.157	.094	.342	-.09	.40
	Case 2	***Case 4***	***.595****	***.111***	***.000***	***.30***	***.89***
	Case 3	***Case 4***	***.439****	***.124***	***.003***	***.12***	***.76***
Safety	Case 1	Case 2	.096	.085	.676	-.13	.32
	Case 1	Case 3	.237	.101	.095	-.03	.50
	Case 1	***Case 4***	***.676****	***.114***	***.000***	***.38***	***.97***
	Case 2	Case 3	.141	.091	.409	-.10	.38
	Case 2	***Case 4***	***.580****	***.105***	***.000***	***.30***	***.86***
	Case 3	***Case 4***	***.439****	***.119***	***.002***	***.13***	***.75***
Perceived Comfort	Case 1	Case 2	-.025	.117	.996	-.33	.28
	Case 1	Case 3	-.003	.114	1.000	-.30	.29
	Case 1	***Case 4***	***.348****	***.110***	***.011***	***.06***	***.64***
	Case 2	Case 3	.023	.106	.997	-.25	.30
	Case 2	***Case 4***	***.374****	***.102***	***.002***	***.11***	***.64***
	Case 3	***Case 4***	***.351****	***.099***	***.003***	***.09***	***.61***
Property Cost	Case 1	Case 2	.054	.135	.978	-.30	.41
	Case 1	Case 3	.247	.135	.265	-.11	.60
	Case 1	***Case 4***	***.984****	***.138***	***.000***	***.62***	***1.35***
	Case 2	Case 3	.193	.135	.483	-.16	.55
	Case 2	***Case 4***	***.930****	***.138***	***.000***	***.57***	***1.29***
	Case 3	***Case 4***	***.737****	***.138***	***.000***	***.38***	***1.10***
*. The mean difference is significant at the 0.05 level.							

Six liveability elements: ***storage, structure quality, internal sound-proof, external sound-proof, private outdoor space*** and ***property cost*** obtained satisfaction rates below 60% in both Case 1 and Case 3 (Figure 6-47 and 6-48). Among them, ***property cost*** (41.2%), ***internal*** and ***external sound-proof*** (51%) had low satisfaction in Case 2. In Case 4, only three elements: *infrastructure* (61.4%), *natural lighting* (61.4%) and heating (57.9%) achieved relatively high satisfaction rates. Satisfaction with ***property cost*** (3.5%), ***internal*** and ***external sound-proof*** (17.5%), ***private outdoor space*** (21.1%), ***view from windows*** (26.3%), and ***storage*** (28.1%) were even lower than

30%. Obviously, Case 4 had many serious liveability issues that need to be improved.

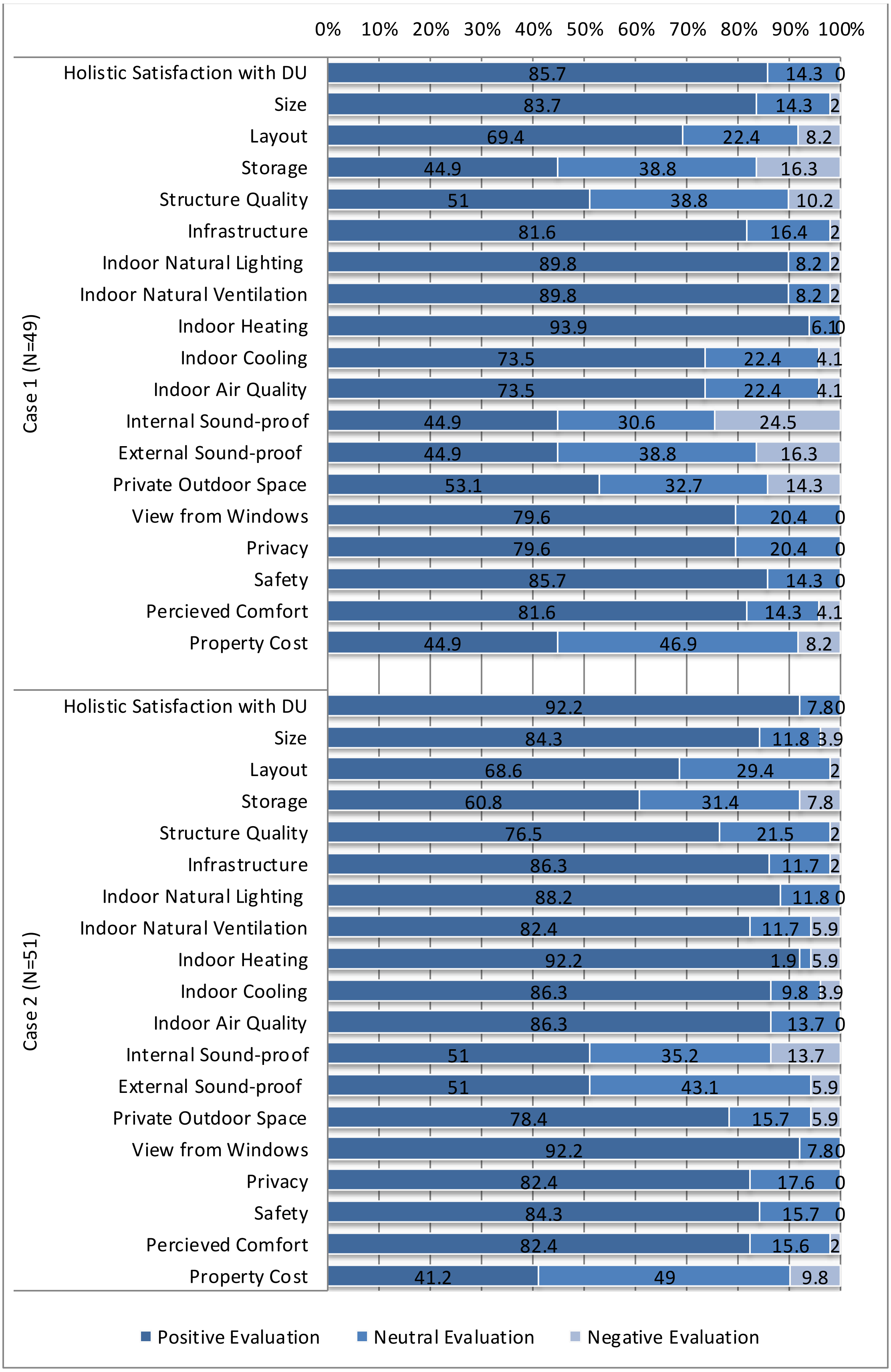


Figure 6- 47 Satisfaction Rates with the 18 Liveability Elements of Dwelling Unit (DU) in Case 1 and Case 2

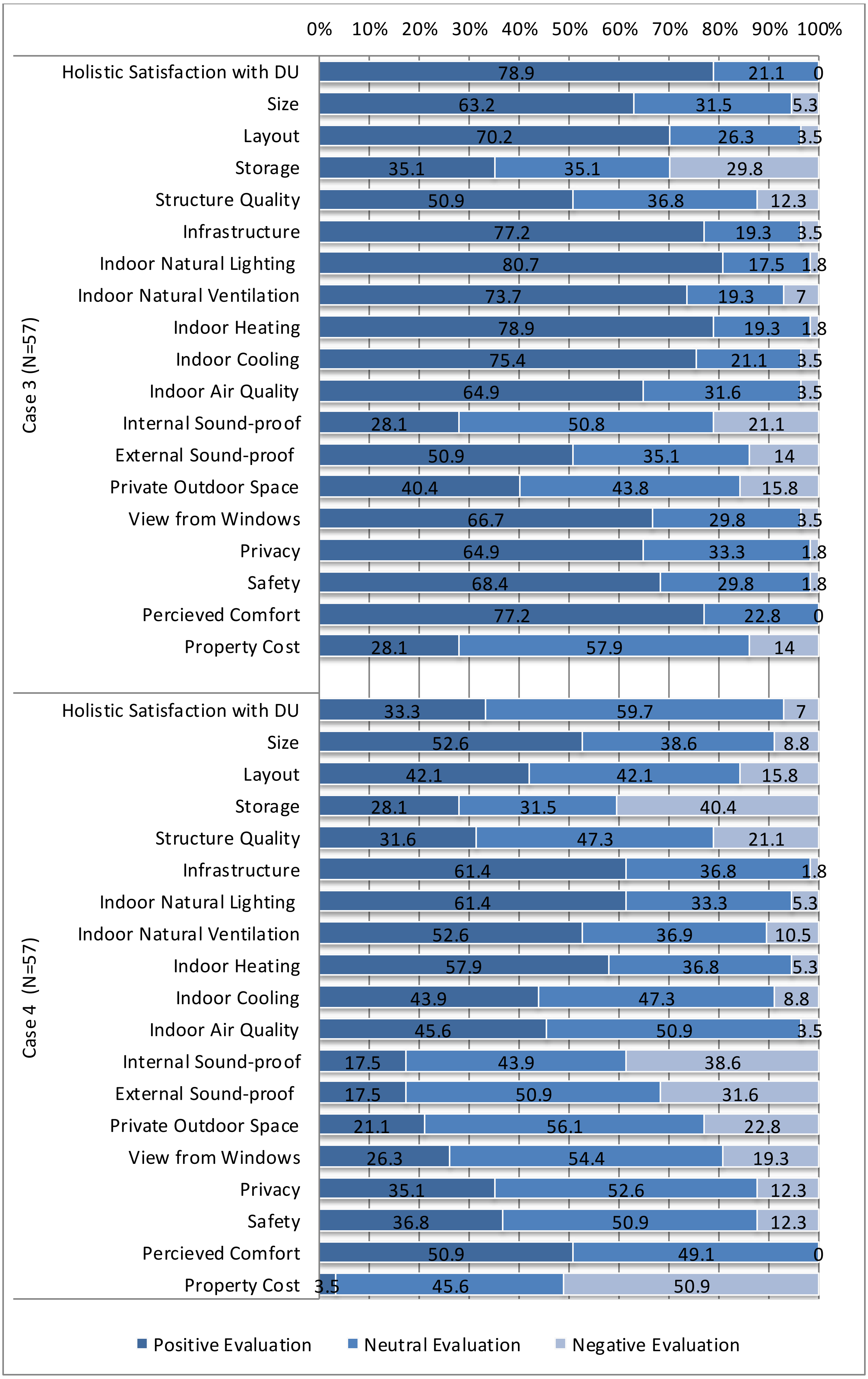


Figure 6- 48 Satisfaction Rates with the 18 Liveability Elements of Dwelling Unit (DU) in Case 3 and Case 4

On the whole, as Figure 6-49 showed, Case 1 and Case 2 achieved the better comprehensive performance at the spatial level of dwelling unit than Case 3, and Case 4 was the lowest at all of aspects. The strengths and weakness of liveability in all of the four cases were similar; ***property cost*** and ***sound-proof*** were the common liveability problems. Shortage of ***storage,*** lack of ***private outdoor space***, and poor ***structure quality*** were complained by the respondents of Case 1, Case 3 and Case 4. Comparatively, ***infrastructure*** (power, water supply and drainage), ***indoor heating*** (urban central heating system***)***, ***natural lighting, ventilation*** and ***perceived comfort*** obtained high satisfaction in all cases, which reflected the main liveability achievements in the current context.

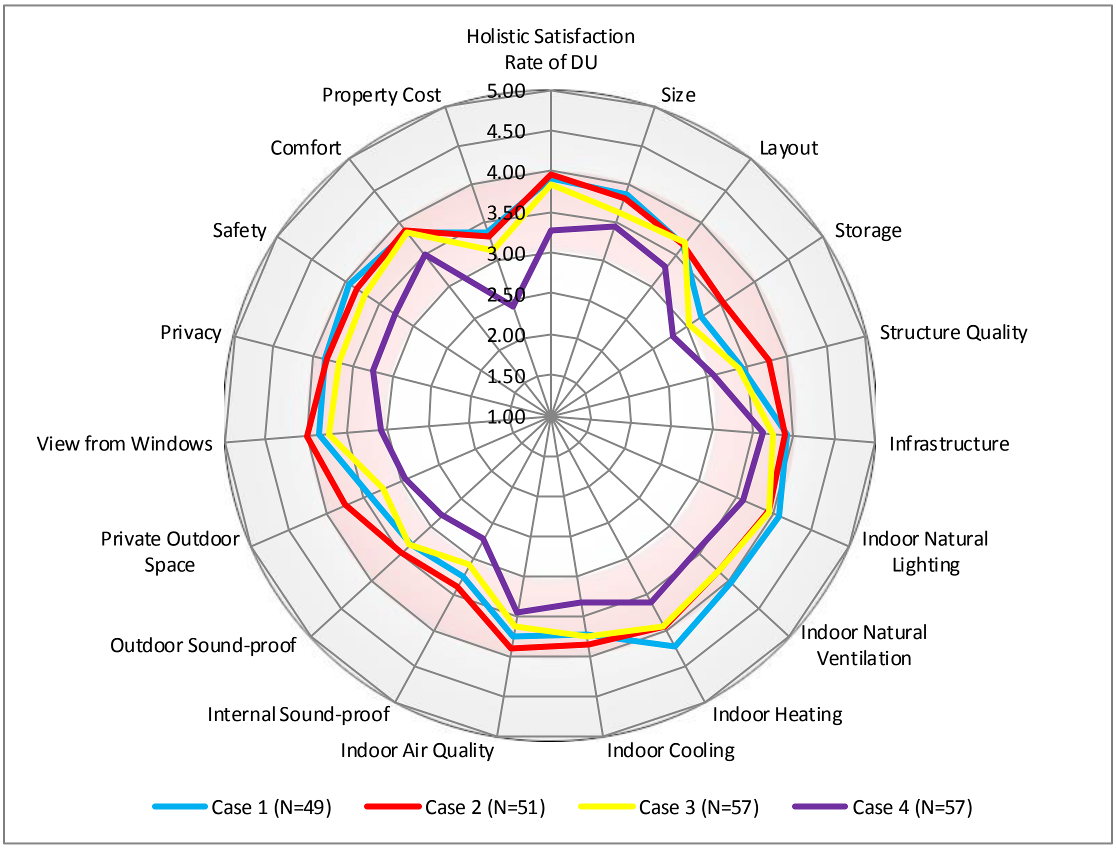
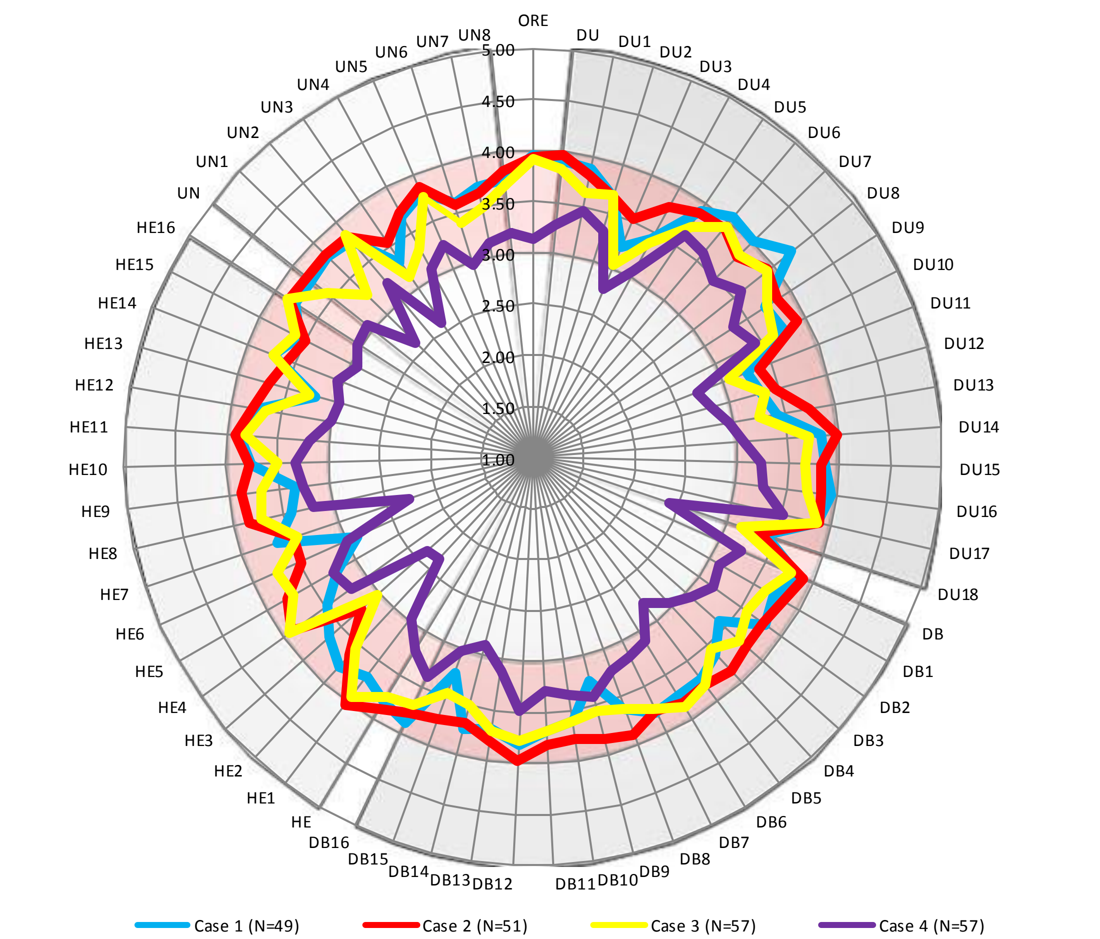


Figure 6-49 Radar Chart of the Satisfaction level of Dwelling Unit (DU) and its 18 Liveability Elements

6.4.4 Summary

Combining all satisfaction levels of overall residential environment, four spatial levels and 58 liveability elements together, it is worth noting that the comprehensive liveability evaluations of the four study cases, representing four typical typologies of high-rise housing estates, are varied, especially between Case 4 and Cases 1, 2 and 3.

As Figure 6-50 indicated, the majority of liveability elements of Case 4 obtained lower satisfaction levels than those of the other cases, and 18 elements even got negative evaluations below the median value -- 3.0. On the contrary, all of the satisfaction levels in the other three cases were higher than the median value, and some elements including ***indoor heating***, ***natural lighting*** and ***ventilation*** in Case 1 and ***green areas and landscape*** in Case 2 even obtained satisfaction levels over the positive value -- 4.0.

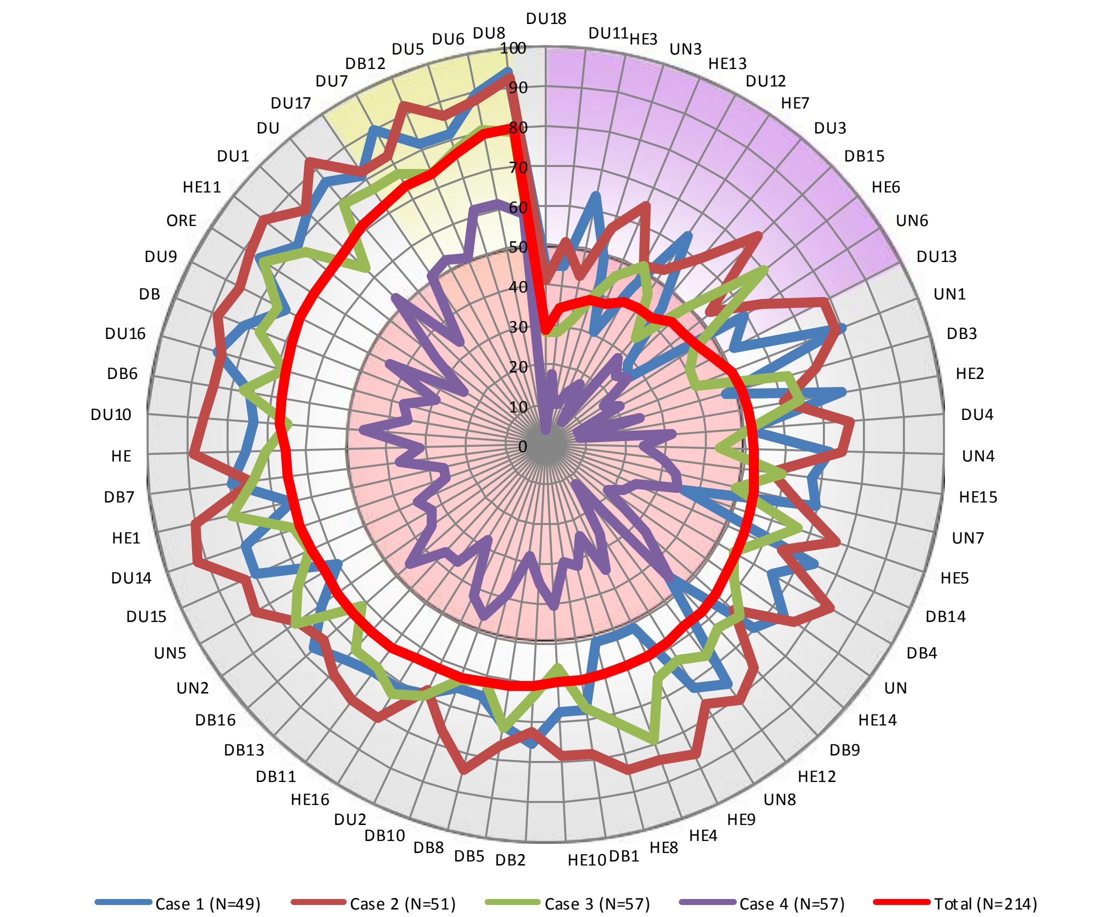


DU	Dwelling Unit	DB	Dwelling Building	HE	Housing Estate	UN	Urban Neighbourhood
DU1	Size	DB1	Building Form	HE1	Green Area and Landscape	UN1	Local Public Space
DU2	Layout	DB2	Building Height	HE2	Play Areas for Children	UN2	Local Service Facilities
DU3	Storage	DB3	Façade Design	HE3	Activity Places for the Elderly	UN3	Noise
DU4	Structure Quality	DB4	Construction Quality	HE4	Pedestrian Walkways	UN4	Traffic Condition
DU5	Infrastructure	DB5	Quality and Quantity of Lifts	HE5	Internal Motor Roads	UN5	Public Transportation
DU6	Indoor Natural Lighting	DB6	Communal Space in Building	HE6	Car/Bike Parking	UN6	Environmental Tidiness
DU7	Indoor Natural Ventilation	DB7	Public Lighting	HE7	Internal Public Service Facilities	UN7	Public Security Situation
DU8	Indoor Heating	DB8	Public Space Ventilation	HE8	Population Density	UN8	Neighbourhood Attachment
DU9	Indoor Cooling	DB9	Barrier-free Design	HE9	Barrier-free Design		
DU10	Indoor Air Quality	DB10	Household Density in Building	HE10	Building Density and Spacing		
DU11	Internal Sound-proof	DB11	Upkeep of Public Facilities and Spaces	HE11	Outdoor Environment in Summer		
DU12	External Sound-proof	DB12	Collection of Domestic Waste	HE12	Outdoor Environment in Winter		
DU13	Private Outdoor Space	DB13	Fire and Earthquake Safety	HE13	Wind Environment		
DU14	View from Windows	DB14	Security in Building	HE14	Maintenance and Management		
DU15	Privacy	DB15	Identity of Building	HE15	Community Security		
DU16	Safety	DB16	Relationship with Neighbours	HE16	Sense of Community	ORE	Overall Residential Environment
DU17	Comfort						
DU18	Property Cost						

Figure 6-50 Study Case Comparison of the Satisfaction Levels of Overall Residential Environment (ORE), Four Spatial Levels and 58 Liveability Elements

6.5 Discussion

As Figure 6-51 showed, according to the ranking of the holistic satisfaction rates (four cases as a whole, N=214), 12 liveability elements obtained the low holistic satisfaction rates below 50%, which revealed the main liveability weaknesses of high-rise housing estates in Tianjin; and 6 liveability elements achieved the high holistic satisfaction rates and over 50% in all four cases, which showed the major liveability strengths.



DU	Dwelling Unit	DB	Dwelling Building	HE	Housing Estate	UN	Urban Neighbourhood
DU1	Size	DB1	Building Form	HE1	Green Area and Landscape	UN1	Local Public Space
DU2	Layout	DB2	Building Height	HE2	Play Areas for Children	UN2	Local Service Facilities
DU3	Storage	DB3	Façade Design	HE3	Activity Places for the Elderly	UN3	Noise
DU4	Structure Quality	DB4	Construction Quality	HE4	Pedestrian Walkways	UN4	Traffic Condition
DU5	Infrastructure	DB5	Quality and Quantity of Lifts	HE5	Internal Motor Roads	UN5	Public Transportation
DU6	Indoor Natural Lighting	DB6	Communal Space in Building	HE6	Car/Bike Parking	UN6	Environmental Tidiness
DU7	Indoor Natural Ventilation	DB7	Public Lighting	HE7	Internal Public Service Facilities	UN7	Public Security Situation
DU8	Indoor Heating	DB8	Public Space Ventilation	HE8	Population Density	UN8	Neighbourhood Attachment
DU9	Indoor Cooling	DB9	Barrier-free Design	HE9	Barrier-free Design		
DU10	Indoor Air Quality	DB10	Household Density in Building	HE10	Building Density and Spacing		
DU11	Internal Sound-proof	DB11	Upkeep of Public Facilities and Spaces	HE11	Outdoor Environment in Summer		
DU12	Enternal Sound-proof	DB12	Collection of Domestic Waste	HE12	Outdoor Environment in Winter		
DU13	Private Outdoor Space	DB13	Fire and Earthquake Safety	HE13	Wind Environment		
DU14	View from Windows	DB14	Security in Building	HE14	Maintenance and Management		
DU15	Privacy	DB15	Identity of Building	HE15	Community Security		
DU16	Safety	DB16	Relationship with Neighbours	HE16	Sense of Community	ORE	Overall Residential Environment
DU17	Comfort						
DU18	Property Cost						

Figure 6-51 Ranking and Study Case Comparison of the Satisfaction Levels of Overall Residential Environment (ORE), Four Spatial Levels and 58 Liveability Elements

The liveability strengths are comprised of dwelling building's ***collection of domestic waste***, and dwelling unit's ***indoor heating***, ***infrastructure, perceived comfort, natural lighting*** and ***ventilation***. The liveability weaknesses consist of urban neighbourhood's ***noise*** and ***tidiness***, housing estate's ***activity places for the elderly***, ***car parking***, ***internal public service facilities***, and ***wind environment***, dwelling building's ***identity***, dwelling unit's ***property cost***, ***internal and external sound-proof***, ***storage*** and ***private outdoor space***. Combined with the findings and conclusions in *Chapter 5*, the following part will in-depth discuss the main liveability strengths and weakness of high-rise housing estates in Tianjin.

1. Liveability strengths of high-rise housing estates in China

It was found that the main liveability achievements of the studied high-rising housing estates concentrated in the indoor environment of dwelling units from two perspectives: 1. the quality of basic infrastructure, and 2. comfort within the dwelling unit.

1) The quality of basic infrastructure

With the rapid economic development of China, both the central and local governments invested large amounts of money and resource into the improvement of urban infrastructure. As analysed in Chapter 4, high-rise housing estates were the outcome of large-scale and high-intensity urban regeneration, and were purpose-built market-oriented housing developments for middle- and high-income class. Therefore, ***the basic infrastructure including water supply system, drainage system, power system, urban central heating system, and so on, were constructed to high standards in current developments***, which was reflected by the high satisfactions of the respondents in all of the four study cases.

2) Comfort within the dwelling unit

From the perspective of Chinese housing culture and tradition, ***natural lighting and ventilation*** have been a key concern and a major factor that guided housing design. Meanwhile, the regulations and codes of housing planning and design that were based on the socialist ideology were still used to control the development intensity especially in terms of insolation interval. Under this circumstance, the design of high-rise housing estates seeks to provide large proportions of dwelling units with south orientation and cross-ventilation while accommodating for high density. The cases in Tianjin have demonstrated considerable success in doing so. Moreover, ***the collection of domestic waste*** that is an important issue to keep high-quality indoor environment achieved high satisfaction in all four cases. Site investigations and interviews found that the property companies of the four cases arranged for workers to collect domestic waste every day, which benefited from the cheap labour in current China.

Last but not least, ***perceived comfort*** in dwelling unit reached the high percentage of satisfaction. In China, because the majority of dwelling units are sold without decoration and fittings, dwelling units were decorated by the buyers themselves. Meanwhile, as shown in the survey (see: Table 6-8), over 90% dwelling units were owner-occupied. In other words, the vast majority of residents are living in their own flats that were decorated by themselves according to their own taste, design and budget. In Chinese culture, the decoration and furnishing can reflect the occupiers' social status and identity, and may influence their fortune and health according to Feng Shui, which makes Chinese people attach great importance to furnishing their dwelling units (Dai 2008). Therefore, many households were willing to spend more money to create a comfortable residential environment, which was significantly different with those who rented flats.

2. Liveability weaknesses of high-rise housing estates in China

1) Poor acoustic environment

The quality of acoustic environment is a significant aspect of liveable residential environment (Yuen 2011). The questionnaire data indicated that noise pollution of high-rise housing estates was one of the key liveability problems. The high-density and long-term redevelopment of inner city resulted in the noise pollution of traffic and construction in surrounding neighbourhood. The poor structure quality, especially in terms of the sound insulation of walls, floors, doors and windows, further deteriorated the indoor acoustic environment of dwelling units.

On the one hand, the internal sound-proof of dwelling unit obtained the second lowest satisfaction (3.09, 34.6%). According to the interview with the 14 respondents, the internal noise came from the following sources:

1) the noise of neighbours due to the poor sound-proof ability of walls and floors;

2) the noise of facilities including elevators, pressurized water supply system, drainage system, and ventilation shaft of kitchen and bathroom in windy weather.

The former was related to the poor sound insulation of the concrete that were widely used as the main material and structure form of high-rise dwelling buildings in China. Moreover, the high household density and the mix of various families especially those with younger children enforced the negative impact of neighbours' noise. Moreover, due to the lack of administrative power in controlling construction quality, developers were used to do shoddy work and use inferior materials in order to reduce the construction cost. Although there were various technical methods to reduce and even resolve the equipment noise, the costs of them were still expensive for the developers. Thus, without the pressure from both market and administrative departments, few developers were willing to adopt the new and expensive technical approaches.

On the other hand, external sound-proof of dwelling unit was identified as a main issue. The majority of interviewees mentioned wind noise, traffic noise and construction noise from the surrounding sites of urban regeneration. Outdoor aerodynamic noise of high-rise building is also a significant issue especially for the clustered high-rise dwelling buildings (Chau, Wong et al. 2004, Lau 2011). In recent years, studies on wind environment of high-rise buildings began to be carried out using wind tunnel experiment and the computer simulation software such as CFD (Computational Fluid Dynamic). Planning and design strategies to reduce wind noise including proper building spacing and layout, simplified building outline, and enclose balcony, etc. have been proposed in some studies (see, Chen 2008, Lau 2011, Liu, Guo et al. 2011, Zhu and Chiu 2011). However, how to optimize the wind environment of the existing high-rise housing estates is an arduous challenge. In the study cases of this research, a dilemma was found, according to the interviews, between the need for natural ventilation and noise insulation of windows, especially in the stuffy summers. Moreover, the high-density inner cities, which are characterized by busy traffic, air pollution and the heat island effect, have forced the residents to make a trade-off between convenience and environmental quaity. In addition, the on-going urban regeneration of the neighbourhoods under study has further reinforced the noise issue, especially in the form of construction noise. For those residents whose dwelling units were located in high floors and on the boundary of community, the noises have become one of the main issues affecting their liveability.

2) Harsh wind environment in high-rise housing estate

In clustered high-rise buildings, wind environment is one of the most significant aspects that influence the local micro-climate (Jones, Alexander et al. 2004, Chen 2008, Lau 2011). A number of studies have been carried out in order to find the proper strategies of planning and design to improve wind environment of high-rise housing estates. However, as is known, the global climate change exacerbates the emergence of extreme weathers, and the existing high-rise residential environments are subject to the test of bad weather. Many interviewees of this study recalled the feeling of fear when the high-rise buildings were shaking in a hurricane. Incidences were also reported of wall tiles and window parts being blown off from high floors in times of strong wind. The harsh wind environment also affected the growth of plants and the use of public spaces and facilities. Although no huge damage has been caused, these events had nonetheless casted shadow on the image of high-rise living.

By comparison among the study cases, it was found that appropriate design could still mediate the wind environment of high-rise housing estates. Case 2 presented a good example due to its significantly higher satisfactions on wind environment. Firstly, the planning layout with taller short-slab buildings on the boundaries encircling various slab buildings in the middle has served to effectively optimize the internal micro-climate (Zhu and Chiu 2011); secondly, the spatial pattern consisting of the diversified high-rise building forms (the various building heights, widths, and outlines) help to improve the wind environment, and prevent high wind speed in extreme weathers (Chen 2009); thirdly, the landscaping with a large number of tall trees has also improved the ground-level wind environment (Yuen 2011); finally, better construction quality and suitable building facade materials (exterior coating paint instead of wall tile) increased the safety standard and reduced chances of accidents in extreme climate.

In later high-rise housing developments, as represented by Cases 3 and 4, however, the above design provisions were gradually lost in the race for maximized plot ratios and minimized construction cost. Therefore, the government should consider the use of regulatory tools such as planning controls or land lease controls (all land in China is owned by the state) to guide the planning and design of high-rise housing estates in order to optimize the wind environment. In some cities, CFD analysis that not only focus on the internal wind environment, but also consider the impact on the surrounding environment has been required for large housing developments (Chen 2009).

3) Shortage of public places and facilities within housing estate

As is shown in Table 6-17, the elderly population aged over 60 accounts for a large proportion of Tianjin's urban population. However, it was found in the study cases that the provision of activity spaces for the elderly had been inadequate and unsatisfactory.

Table 6- 17 Proportion of the Aging Population in Tianjin by the end of 2011

Age Groups	Total		Male		Female	
	City	Inner city	City	Inner city	City	Inner city
Age 60 and over (Million)	1.8743	0.9078	0.9052	0.4327	0.9691	0.4751
Proportion in Total (%)	18.81	22.77	18.07	21.73	19.56	23.82
Age 65 and over (Million)	1.2750	0.6466	60.82	0.3026	0.6668	0.3440
Proportion in Total (%)	12.80	16.22	12.14	15.20	13.46	17.24
Age 80 and over (Million)	0.2952	17.76	0.1354	0.0821	0.1598	0.0955
Proportion in Total (%)	2.96	4.45	2.70	4.13	3.22	4.78

Source: Tianjin Statistic Yearbook of 2012 (SONBS 2012)

Due to the large scale of these housing estates, the elderly residents preferred to stay inside the community and participate in internal activities. However, it was difficult for them to find the proper place to spend the leisure time within the gated communities. Although there are community centres in all of the 4 cases, few of the facilities provided were suitable for aged people. The charges on the usage of these facilities further drove off the elderlies, who were generally less well-off than the younger generations. Thus, the central squares had become a favourite gather place for the elderlies to play Chinese chess, look after the younger children, chat with friends, exercise, and so on (Figure 6-52). However, these open-air places lack the necessary facilities including sunshades, chairs and tables that provide a comfortable environment especially in the summer and winter times. Behind the phenomenon, it lays the failure of current developments to address the problem of an aging society. Until now, there is no comprehensive regulation or code to stipulate the planning and design of the activity places for the elderly in housing estates.

Figure 6-52 Outdoor Spaces for the Elderly Residents within high-rise housing estates

The types and sizes of the internal public service facilities have been planned and constructed according to the regulations and codes of urban housing planning, and it is the important content of planning administration to guarantee the supply of the necessary facilities including community centre, convenience store, market and parking space. However, in actual use, the gated management of housing estates limited the service population of these internal facilities and increased the operating cost, and the higher cost caused more residents to choose external facilities, which further resulted in the difficulty of operation and even closing down of the internal facilities. As a common phenomenon in all study cases, a vicious cycle had been formed with increasing numbers of empty shops in the community and decreasing conveniency for residents. The contradiction between the regulated planning and the actual usage of community facilities reveals an inherit problem with the current form of gated communities and their relationship with the outer neighbourhood. The relationship between the gated community and its surrounding neighbourhood is affected by the scale, form, and spatial configuration of the gated community, which the current provisions of design guidance failed to identify. Therefore, it is necessary to revisit some of the current provisions and make modifications based on evidence provided by empirical studies.

4) Poor identity of dwelling building

In the current process of inner-city regeneration, the majority of new housing is being developed as large-scale gated residential estates designed and constructed by a single developer. To maximize profit, monotonous housing designs prevailed. As a result, the clustered high-rise buildings with the same facade design were easy to make people feel disoriented, especially for visitors. In fact, as the study of Wonpi Kim (1997) and Peggy Teo (1996) indicated, the great height and volume of high-rise dwelling buildings was the important factor to result in the poor identity. Furthermore, the lack of a clear signage system had often exacerbated the situation. Although some form of direction system had been provided (see, Figure 6-49), the large-scale monotonous built environment has made it difficult for one to find the right positions as well as being dull in aesthetical terms.

Figure 6-53 Three-level Identification System in Case 3
Top left: the monotonous and large-scale dwelling buildings; top right: the map of housing estate near

the guarded entrance; bottom right: the simplified destination board on the crossroad; bottom left: the signage of dwelling building that is difficult to find.

As a response to the poor identity, at the level of urban planning management, on the one hand, the diversified building form and facade design of dwelling buildings within one housing estate should be encouraged or required; on the other hand, the land size of high-rise housing estate should be appropriately controlled in order to decrease the number of high-rise dwelling buildings with same appearance. At the level of community management, the clear and standardized signage and direction system should be established to improve the identity.

5) Shortage of auxiliary spaces of dwelling unit

In the liveability evaluation of the existing high-rise housing estates, storage space and private outdoor space were both given low satisfaction rates, especially for families with children. With the Chinese residential tradition of collective living, the storage of personal items in the communal space was a common phenomenon in both shared court-yard houses and Soviet-style compounds. As a newly-emerged private property market, the new high-rise housing has largely overlooked such provisions as private storage space. Through the site survey, it was found that the public spaces such as corridors and stair wells were often occupied to store private belongings of the residents, and some balconies were transformed into kitchen and storage space. Obviously, these behaviours inevitably increased the potential safety and security risk including fire and theft. Moreover, due to the unsuitable design of open balconies under the climatic conditions of Tianjin, the majority of residents have transformed the open balconies into enclosed indoor space by installing windows. As a result, the private outdoor spaces are being replaced by the indoor sun rooms in many new housing estates.

6) Poor affordability

Among the 58 liveability elements, property cost was found to be the element with the lowest satisfaction rate (28.5%) and satisfaction level (3.05). Generally speaking, property cost consists of three parts: the rental or mortgage fee, property management fee, and utility cost. According to a sample survey of the real estate markets of 10 metropolitan cities in China in 2006(Lu 1999), the monthly mortgage fee accounted for 44% of the monthly family income in Tianjin. As there is a very high percentage of home-ownership in the study cases (93.9% owner-occupiers) as well as in general due to the complicated historical and cultural tradition of China (Song, Knaap et al. 2005), the mortgage fee has become the main part of the living expenses for each urban family. Property management fees vary with the floor area of the flat and the service standard of the housing estate. Utility costs include the municipal centralized heating fee, energy fee (electricity and gas) and water fee.

Based on the survey data and the statistical data of Tianjin Bureau of Statistics, the average property management fee and utility costs were calculated (Table 6-18). Because of the lack of data on gas consumption, the total expenses did not contain the gas fee. From the perspective of income, according to Tianjin Statistical Yearbook of 2011, the average family annual income in Tianjin was 69235.05 RMB (6924GBP). Obviously, more than half of family income has been spent on housing, which was significant higher than the reasonable housing expense ratio of 28% (Chen and Song 2010).

Table 6- 18 Property Cost in 4 Cases (Mortgage fee excluded)

Index	Unit	Case 1 ShengDa Garden	Case 2 Style of Spring	Case 3 Tianlin Garden	Case 4 BaoLong Bay
Average property management fee [1]	RMB / Year[5]	110*1.5*12 =1980	124*1.8*12 =2678.4	128*2.2*12 =3379.2	120*1.8*12 =2592
Average heating Fee [2]		110*0.8*25 =2200	124*0.8*25 =2480	128*0.75*25 =2400	120*0.75*25 =2250
Average electricity Fee [3]		533*3.2*0.49=835.744			
Average water Fee [4]		48.2*3.2*3.9=601.536			
Total expenses		5617.28	6595.68	7216.48	6279.28

1. =Average floor area per household*Property management price per square meter
2. =Average floor area per household*Heating floor area coefficient*Heating price
3. =Electricity consumption per resident*Average household population*Electricity price
4. =Water consumption per resident* Average household population*Water price
5. Exchange rate between RMB and Pound Sterling was approximate 10/1 in 2012

Source: community survey information and Tianjin Statistical Yearbook 2011

In the interviews with the residents, it was found that the increasing service charge of property management was one of the key reasons why many residents were dissatisfied with the property cost of high-rise housing. In Case 1 and Case 2, with the consent of the property owners' committee, the service fees had increased 25% in 2011. However, almost all of the interviewed respondents questioned the decision of the committees, and believed that the service fees were too high for the low quality management and maintenance provided by the property management companies. On this issue, the property managers of the four study cases interviewed by the author provided a more comprehensive explanation: Firstly, the fundamental infrastructure and service facilities of high-rise buildings such as secondary pressurized water supply system and vertical transportation system are generally costly to maintain. Secondly, a vicious cycle was often created by the continued rise of maintenance cost due to the aging of the facilities and the high failure rate of current low-quality equipment and the increased resistance of residents on the payment of service charge based on the felt deteriorated service quality. Consequently, the contradictions between the property management companies and residents inevitably intensified. The companies need higher service charge to maintain and manage the high-rise housing estates, but the residents are unwilling to pay more money for the service. According to the interviews, both the property managers and the residents said that some residents chose to move to other housing types, which resulted in the low occupancy rate, and some dwelling units were rented for non-residential use such as storage and offices, which not only increased the difficulty of community management, but also brought the negative impact on the community security and reputation.

6.6 Conclusion

This chapter has achieved the third research objective:

> *To analysis the residents' liveability evaluation of the high-rise residential environment, explore the strengths and weaknesses of liveability of the existing high-rise housing estates in China to inform the practical development;*

This chapter first analysed the basic data of the liveability questionnaire survey from four aspects: the questionnaire's reliability, the respondents' demographic features and residential environment features, and the correlation between them. Based on statistics analysis, it was concluded that the content reliability and internal consistency of the questionnaire achieved a high level.

The demographic structure of the respondents revealed a core characteristic of high-rise housing estate in the inner city of Tianjin: ***the residents were mixed different household types based on the middle income level*** The distribution of the respondents' residential environment features in the four cases was consistent with each case's actual constitution of dwelling units and dwelling buildings. The outcomes of correlation analysis between demographic features and residential environment features indicated that ***the higher family income and larger household size the respondents had the better residential environment they enjoyed***.

Next, the holistic liveability evaluations (4 cases as a whole, N=214) were analysed at three hierarchical layers: the overall residential environment, the four spatial levels, and 58 liveability elements. The results indicated that nearly 70% of the respondents were satisfied with their overall high-rise residential environment, while less than 4% of them were dissatisfied; a trend can be identified that the levels of satisfaction decreased with the expansion of the spatial levels from dwelling unit, dwelling building, housing estate to urban neighbourhood; some liveability elements, such as ***noise*** and ***tidiness*** of neighbourhood, ***activity places for the elderly***, ***wind environment, internal public service facilities*** and ***car parking*** in housing estate, ***identity*** and ***facade design*** of dwelling building, and ***property cost***, ***sound-proof***, ***storage*** and ***private outdoor space*** of dwelling unit, obtained low satisfactions.

And then, the liveability evaluations of the four study cases were compared at three hierarchical layers: the overall residential environment, the four spatial levels, and 58 liveability elements. The outcomes revealed that the satisfactions with the overall residential environment and the four spatial levels in Case 4 were significantly lower than those in the other three cases, which supported the findings and conclusions of qualitative survey in Chapter 5.

The comparison of the satisfactions with the 58 liveability elements between the four cases further explored the detailed liveability evaluations at the four spatial levels: urban neighbourhood, housing estate, dwelling building and dwelling unit. Differed from the more mature neighbourhoods (Case 1 and Case 2), the brand new neighbourhood (Case 3) and the neighbourhood under regeneration (Case 4) faced some liveability issues such as ***lack of public spaces*** and ***traffic congestion*** due to higher development intensity and population density. At the spatial level of housing estate, moderate development intensity, high-quality planning and careful community management in Case 2 formed a more liveable community environment than the other cases. ***The lack of places for the elderly*** and ***the poor wind environment*** were found to be the common liveability problems in all four cases. At the spatial level of dwelling building, the different architecture designs and building forms in the four study cases resulted in the distinctive liveability problems, with ***building identity*** and

facade design identified as the main common liveability issues. At the spatial level of dwelling unit, ***property cost***, ***sound-proof*** and shortage of ***storage and private outdoor space*** were the common liveability problems in all of the 4 cases. Comparatively, ***infrastructure***, ***indoor heating***, ***natural lighting, ventilation*** and ***perceived comfort*** obtained high satisfaction in all cases, which reflected the main liveability achievements in the current context.

Integrating the holistic and each case's liveability evaluations, the liveability strengths and weaknesses of high-rise housing estates were respectively summarized. ***High-quality indoor environment*** of dwelling unit was the major liveability achievement due to the high standard infrastructure including water supply system, drainage system, power system, and urban central heating system, the large proportion of south orientation and natural cross-ventilation, and interior decoration according to personal tastes. The liveability problems were mainly focused on the six aspects:

1. ***Poor acoustic environment*** (noise pollution in urban neighbourhood and poor sound-proof of dwelling unit);
2. ***Harsh wind environment;***
3. ***Shortage of public places and facilities within housing estate;***
4. ***Poor identification of dwelling building;***
5. ***Shortage of auxiliary spaces of dwelling unit***
6. ***Poor affordability.***

These problems revealed the common weaknesses of high-rise housing estates in the context of Tianjin, and they should be carefully analysed and studied in-depth in order to find solutions and ways to improve, and inform the future high-rise housing development. Above all, based on the data analysis of questionnaire survey, this chapter analysed the experiences and lessons, summarized the strengths and weaknesses from the practical perspective. The following chapter will focus on the theoretical issues on the liveability of high-rise housing estates.

Chapter seven

Discussion: constructing the conceptual framework of the liveability of high-rise housing estates in China

7.1 Introduction

This chapter is focus on answering the Fourth research question:

> '*What are the relationships between the residents' liveability evaluation, demographic features and residential environment features, and what are the measurement, indicators and dimensions of the liveability of high-rise housing estates from the theoretical perspective?'*

In this chapter, the theoretical issues on liveability of high-rise housing estates will be in-depth analysed in seven aspects: the correlation between residents' demographic features and liveability evaluation, the correlation between residents' residential environment features and liveability evaluation, the correlation between residents' demographic features and residential environment features, the contribution of four spatial levels (dwelling unit, dwelling building, housing estate and urban neighbourhood) to the satisfaction with overall residential environment, the measurement, indicators and dimensions of the liveability of high-rise housing estates.

7.2 Correlation between respondents' demographic features and liveability evaluation of high-rise housing estates

Correlation Analysis has been carried out to reveal the relationships between the demographical characteristics of respondents and the satisfaction levels with the overall residential environment and the 4 fundamental residential environmental components. First of all, two features: *family income* and *household size* had significant correlations with the satisfaction levels with overall residential environment of high-rise housing estates (p< .001, Table 7-1). Furthermore, the satisfaction distribution clearly indicated two trends: the higher the family incomes of the respondents were, the higher the satisfactions were; and generally, larger families had higher satisfaction. Moreover, from the perspective of the life-stage of the respondents, elderly (couple)s living alone have lower satisfaction than those living with their children. Young couples with younger children had no significant difference with other groups, which is inconsistent with the conclusions of many empirical studies in the western context (See, Morville 1969a, Currie and Yelowitz 2000, Fincher 2004). Secondly, the results of the Correlation Analysis clearly showed that, *family income* was significantly correlated to the satisfaction with dwelling unit, dwelling building, housing estate and urban neighbourhood, with the higher the income, the higher the satisfaction. In addition, *household size* had a significant correlation with the satisfaction with dwelling building. The respondents who had larger family expressed higher satisfaction with their dwelling buildings. To sum up, among the 6 demographical features, ***family income*** and ***household size*** of the respondents revealed significant correlations with the satisfaction of the majority of residential environmental components. The respondents with higher income and larger family were more satisfied with their high-rise residential environment. Different to many studies on high-rise housing, the respondents with different gender, age, degree of education and life stage have not shown significant different satisfactions in developed countries (see: Williamson 1981, Marmot 1983, Fincher 2004).

Table 7- 1 Analysis of Correlation between Demographical Features of the Respondents and the Satisfactions

Satisfaction with		DF1	DF2	DF3	DF4	DF5	DF6
Overall Residential Environment	Pearson Correlation	.025	-.102	.080	**.288****	**.233****	-.006
	Sig. (2-tailed)	.716	.137	.245	**.000**	**.001**	.933
Dwelling Unit	Pearson Correlation	-.022	.036	.100	**.250****	.106	.018
	Sig. (2-tailed)	.748	.603	.146	**.000**	.123	.793
Dwelling Building	Pearson Correlation	-.073	.046	.096	**.303****	**.161***	.014
	Sig. (2-tailed)	.288	.505	.160	**.000**	**.018**	.841
Housing Estate	Pearson Correlation	-.042	.046	.061	**.167***	-.019	.005
	Sig. (2-tailed)	.543	.503	.377	**.014**	.780	.938
Urban Neighbourhood	Pearson Correlation	-.062	.043	-.012	**.218****	.078	.063
	Sig. (2-tailed)	.366	.531	.857	**.001**	.255	.362

DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

At the spatial level of urban neighbourhood, the result of Correlation Analysis indicated that gender and degree of education of the respondents did not have significant correlation with the satisfactions of 8 liveability elements (Table 7-2). Age of the respondents was significantly negatively correlated to the satisfactions with local service facilities, which meant that older residents were more dissatisfied with neighbourhood service facilities. The respondents' family income have significant positive correlation with 6 out of 8 liveability elements, except environmental tidiness and public security situation, followed by household size of the respondents with 5 elements. In the other word, the respondents with higher family income and larger household size were more satisfied with these liveability elements.

Table 7-2 Correlation Analysis of Demographic Features of Respondents and the Satisfactions with 8 Liveability Elements of Urban Neighbourhood (UN)

Satisfactions with		DF1	DF2	DF3	DF4	DF5	DF6
Local Public Space	Pearson Correlation	-.059	-.068	.105	**.258****	**.136***	-.014
	Sig. (2-tailed)	.388	.324	.127	**.000**	**.047**	.836
Local Service Facilities	Pearson Correlation	.127	**-.200****	.126	**.181****	**.150***	-.098
	Sig. (2-tailed)	.064	**.003**	.067	**.008**	**.029**	.153
Noise	Pearson Correlation	.006	**.138***	.034	**.214****	.033	.089
	Sig. (2-tailed)	.931	**.044**	.617	**.002**	.629	.197
Traffic Condition	Pearson Correlation	.004	.101	-.007	**.227****	**.197****	.071
	Sig. (2-tailed)	.956	.139	.919	**.001**	**.004**	.301
Public Transportation	Pearson Correlation	-.062	-.019	.078	**.251****	**.158***	-.020
	Sig. (2-tailed)	.363	.786	.254	**.000**	**.021**	.769
Environmental Tidiness	Pearson Correlation	-.047	-.027	-.021	.028	-.027	.008
	Sig. (2-tailed)	.490	.691	.761	.686	.695	.912
Public Security Situation	Pearson Correlation	-.080	-.093	.058	.119	.027	**-.141***
	Sig. (2-tailed)	.245	.177	.402	.083	.697	**.040**
Neighbourhood Attachment	Pearson Correlation	.055	-.079	.050	**.188****	**.197****	.009
	Sig. (2-tailed)	.424	.252	.468	**.006**	**.004**	.899

DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

At the spatial level of housing estate, the family income of the respondents was significantly correlated to the satisfactions with 12 out of 16 liveability elements (Table 7-3). The same trend was revealed: higher family income accompanied higher satisfaction. Family income of the respondents was still the key feature that were significantly positively correlated to the satisfaction with 13 liveability elements, followed by household size with 5 elements, and education degree with 2 elements. The respondents' age had significant positive correlation with the satisfaction of only one element: population density. Moreover, gender and life stage of the respondents did not have significant correlations with any element's satisfaction.

Table 7-3 Correlation Analysis of Demographic Features of Respondents and the Satisfactions with 16 Liveability Elements of Housing Estate

Satisfaction with		DF1	DF2	DF3	DF4	DF5	DF6
Green Area and Landscape	Pearson Correlation	.033	.030	-.007	.134	**.219****	.116
	Sig. (2-tailed)	.632	.663	.923	.051	**.001**	.091
Play Areas for Children	Pearson Correlation	.038	.020	-.024	.116	**.187****	.071
	Sig. (2-tailed)	.576	.769	.728	.089	**.006**	.303
Activity Places for the Elderly	Pearson Correlation	.072	.067	.130	**.145***	.027	.127
	Sig. (2-tailed)	.291	.330	.057	**.034**	.695	.064
Pedestrian Walkways	Pearson Correlation	-.016	.022	.051	**.197****	.115	.058
	Sig. (2-tailed)	.811	.751	.462	**.004**	.094	.402
Internal Roads	Pearson Correlation	-.023	-.037	.112	**.218****	**.152***	-.015
	Sig. (2-tailed)	.738	.587	.103	**.001**	**.027**	.831
Car Parking	Pearson Correlation	-.070	.046	**.134***	**.254****	.049	.051
	Sig. (2-tailed)	.306	.503	**.050**	**.000**	.472	.456
Internal Public Service Facilities	Pearson Correlation	-.030	.023	**.154***	**.146***	.036	.054
	Sig. (2-tailed)	.662	.734	**.025**	**.033**	.604	.433
Population Density	Pearson Correlation	-.073	**.147***	.068	**.298****	**.143***	.106
	Sig. (2-tailed)	.290	**.032**	.322	**.000**	**.036**	.123
Barrier-Free Designs	Pearson Correlation	.020	.051	.069	**.228****	.078	.014
	Sig. (2-tailed)	.766	.461	.314	**.001**	.255	.837
Building Density and Spacing	Pearson Correlation	.022	.063	-.038	**.200****	.113	.084
	Sig. (2-tailed)	.748	.361	.579	**.003**	.100	.219
Outdoor Environment in Summer	Pearson Correlation	.079	.105	.018	**.218****	.000	.068
	Sig. (2-tailed)	.250	.126	.793	**.001**	.996	.321
Outdoor Environment in Winter	Pearson Correlation	.046	.049	.014	**.229****	.016	.066
	Sig. (2-tailed)	.501	.479	.833	**.001**	.813	.333
Wind Environment	Pearson Correlation	.100	-.004	-.005	.126	**.150***	.035
	Sig. (2-tailed)	.146	.949	.942	.065	**.028**	.611
Maintenance and Management	Pearson Correlation	.118	.010	-.105	.113	.128	.118
	Sig. (2-tailed)	.085	.883	.125	.100	.061	.086
Community Security	Pearson Correlation	.120	.032	.036	**.215****	.107	.098
	Sig. (2-tailed)	.081	.637	.597	**.002**	.117	.152
Sense of Community	Pearson Correlation	-.023	.024	-.015	**.146***	.088	-.034
	Sig. (2-tailed)	.736	.726	.826	**.033**	.199	.621
DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.							
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N=214							

At the spatial level of dwelling building, both gender and life stage of the respondents did not have any significant correlations with the satisfaction of all of the 16 liveability elements (Table 7-4). The respondents' age was significantly correlated with the satisfaction with ventilation of public space within dwelling building, and older respondents were more satisfied with it. The education degree of respondents existed positive correlation with the satisfaction of communal space design and public lighting. The respondents' household size had significant positive correlation with the satisfactions of 5 elements. Similarly, the level of family income was the main feature that was significantly positively correlated to the satisfaction of 12 elements.

Table 7-4 Correlation Analysis of Demographic Features of Respondents and the Satisfactions with 16 Liveability Elements of Dwelling Building

Satisfaction with		DF1	DF2	DF3	DF4	DF5	DF6
Building Form	Pearson Correlation	.033	.030	-.007	.134	**.219****	.116
	Sig. (2-tailed)	.632	.663	.923	.051	**.001**	.091
Building Height	Pearson Correlation	.038	.020	-.024	.116	**.187****	.071
	Sig. (2-tailed)	.576	.769	.728	.089	**.006**	.303
Façade Design	Pearson Correlation	.072	.067	.130	**.145***	.027	.127
	Sig. (2-tailed)	.291	.330	.057	**.034**	.695	.064
Construction Quality	Pearson Correlation	-.016	.022	.051	**.197****	.115	.058
	Sig. (2-tailed)	.811	.751	.462	**.004**	.094	.402
Quality and Quantity of Lifts	Pearson Correlation	-.023	-.037	.112	**.218****	**.152***	-.015
	Sig. (2-tailed)	.738	.587	.103	**.001**	**.027**	.831
Communal Space Design	Pearson Correlation	-.070	.046	**.134***	**.254****	.049	.051
	Sig. (2-tailed)	.306	.503	**.050**	**.000**	.472	.456
Public Lighting	Pearson Correlation	-.030	.023	**.154***	**.146***	.036	.054
	Sig. (2-tailed)	.662	.734	**.025**	**.033**	.604	.433
Public Space Ventilation	Pearson Correlation	-.073	**.147***	.068	**.298****	**.143***	.106
	Sig. (2-tailed)	.290	**.032**	.322	**.000**	**.036**	.123
Barrier-Free Designs	Pearson Correlation	.020	.051	.069	**.228****	.078	.014
	Sig. (2-tailed)	.766	.461	.314	**.001**	.255	.837
Household Density	Pearson Correlation	.022	.063	-.038	**.200****	.113	.084
	Sig. (2-tailed)	.748	.361	.579	**.003**	.100	.219
Upkeep of Public Facilities	Pearson Correlation	.079	.105	.018	**.218****	.000	.068
	Sig. (2-tailed)	.250	.126	.793	**.001**	.996	.321
Collection of Domestic Waste	Pearson Correlation	.046	.049	.014	**.229****	.016	.066
	Sig. (2-tailed)	.501	.479	.833	**.001**	.813	.333
Fire and Seismic Safety	Pearson Correlation	.100	-.004	-.005	.126	**.150***	.035
	Sig. (2-tailed)	.146	.949	.942	.065	**.028**	.611
Security in Building	Pearson Correlation	.118	.010	-.105	.113	.128	.118
	Sig. (2-tailed)	.085	.883	.125	.100	.061	.086
Identity of Building	Pearson Correlation	.120	.032	.036	**.215****	.107	.098
	Sig. (2-tailed)	.081	.637	.597	**.002**	.117	.152
Relation with Neighbours	Pearson Correlation	-.023	.024	-.015	**.146***	.088	-.034
	Sig. (2-tailed)	.736	.726	.826	**.033**	.199	.621

DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

At the spatial level of dwelling unit, gender of the respondents was significantly related to the satisfaction with storage and private outdoor space, and female respondents expressed lower satisfaction level than male (Table 7-5). Older respondents had higher satisfaction with indoor air quality and private outdoor space. Moreover, the respondents' degree of education had significant positive correlations with the satisfaction with structure quality, property cost, internal sound-proof and external sound-proof. Household size of the respondents was significantly related to the satisfaction with privacy, safety and comfort, and larger families were more satisfied with these three elements. Life stage of the respondents had significant correlations with the satisfaction with indoor air quality, private outdoor space and view from windows. The satisfactions with 13 out of 18 liveability elements were significantly positively correlated to family income.

Table 7-5 Correlation Analysis of Demographic Features of Respondents and the Satisfactions with 18 Liveability Elements of Dwelling Unit

Satisfaction with		DF1	DF2	DF3	DF4	DF5	DF6
Size	Pearson Correlation	.060	.078	.012	**.166***	-.004	.126
	Sig. (2-tailed)	.384	.254	.856	**.015**	.954	.066
Layout	Pearson Correlation	-.048	.052	.055	**.174***	.017	.059
	Sig. (2-tailed)	.488	.447	.421	**.011**	.806	.391
Storage	Pearson Correlation	**-.146***	.095	.064	.105	-.030	.090
	Sig. (2-tailed)	**.033**	.167	.348	.125	.658	.189
Structure Quality	Pearson Correlation	-.114	.001	**.211****	**.284****	.099	-.048
	Sig. (2-tailed)	.096	.992	**.002**	**.000**	.148	.482
Infrastructure	Pearson Correlation	-.030	.015	.118	.076	.048	-.051
	Sig. (2-tailed)	.657	.833	.085	.267	.480	.459
Natural Lighting	Pearson Correlation	.015	-.125	.031	.085	.069	-.007
	Sig. (2-tailed)	.824	.069	.653	.217	.312	.918
Natural Ventilation	Pearson Correlation	-.029	.072	.058	**.159***	.118	.091
	Sig. (2-tailed)	.670	.297	.399	**.020**	.086	.185
Heating in Winter	Pearson Correlation	.021	-.012	.115	.114	.032	-.003
	Sig. (2-tailed)	.760	.862	.093	.096	.640	.960
Cooling in Summer	Pearson Correlation	.072	.027	.134	.129	.087	.018
	Sig. (2-tailed)	.294	.693	.051	.060	.203	.788
Indoor Air Quality	Pearson Correlation	-.033	**.179****	-.002	**.147***	.031	**.136***
	Sig. (2-tailed)	.627	**.009**	.980	**.032**	.655	**.047**
Internal Sound-proof	Pearson Correlation	-.072	.069	**.143***	**.325****	.124	.026
	Sig. (2-tailed)	.291	.313	**.037**	**.000**	.069	.711
External Sound-proof	Pearson Correlation	-.094	.103	**.161***	**.279****	.062	.017
	Sig. (2-tailed)	.171	.133	**.019**	**.000**	.370	.808
Private Outdoor Space	Pearson Correlation	**-.167***	**.154***	.008	**.229****	.085	**.154***
	Sig. (2-tailed)	**.014**	**.024**	.908	**.001**	.218	**.025**
View	Pearson Correlation	-.050	.116	.083	**.197****	.114	**.144***
	Sig. (2-tailed)	.471	.091	.228	**.004**	.096	**.036**
Privacy	Pearson Correlation	-.062	.112	-.039	**.227****	**.157***	.098
	Sig. (2-tailed)	.368	.103	.572	**.001**	**.021**	.152
Safety	Pearson Correlation	-.095	-.098	.111	**.247****	**.155***	.021
	Sig. (2-tailed)	.165	.154	.106	**.000**	**.023**	.755
Comfort	Pearson Correlation	-.128	-.011	.031	**.163***	**.136***	.074
	Sig. (2-tailed)	.062	.874	.647	**.017**	**.047**	.283
Property Cost	Pearson Correlation	-.041	-.096	**.219****	**.166***	.071	-.092
	Sig. (2-tailed)	.546	.161	**.001**	**.015**	.305	.180
DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.							
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N=214							

To sum up, among the six demographic features, only family income was significantly correlated to the satisfaction with the majority of liveability elements, and the satisfaction increased with the increase of family income.

7.3 Correlation between respondents' residential environment features and liveability evaluation of high-rise housing estates

The respondents' residential environmental features have been summarized from the aspects of physical dimension and psycho-social dimension in *Section 6.2*. The relationships between these features and the satisfaction with overall residential environment and the four spatial levels were analysed by the statistical means of Correlation Analysis and Analysis of Variance in SPSS. In the physical dimension, the outcomes of Correlation Analysis indicated that the dwelling unit's *orientation and ventilation*, and dwelling building's *layout*, *building form* and *location in housing estate*, and housing estate's *planning layout*, have significant correlations with the satisfaction with both overall residential environment and its four spatial levels (Table 7-6). The *size of dwelling units* was significantly correlated to all the satisfaction except that of housing estate. It is worth noting that there was no significant correlation between the storey of dwelling units where the respondents were living in and their satisfaction.

Table 7-6 Correlation Analysis of the Physical Features of Residential Environment and Satisfactions of the Respondents

Satisfaction with			DU1	DU2	DU3	DB1	DB2	DB3	HE
Overall Residential Environment		Pearson Correlation	**.290****	-.026	**-.211****	**-.304****	**-.297****	**.241****	**-.417****
		Sig. (2-tailed)	**.000**	.707	**.002**	**.000**	**.000**	**.000**	**.000**
	Dwelling Unit	Pearson Correlation	**.190****	.027	**-.183****	**-.337****	**-.327****	**.247****	**-.421****
		Sig. (2-tailed)	**.005**	.693	**.007**	**.000**	**.000**	**.000**	**.000**
	Dwelling Building	Pearson Correlation	**.221****	-.072	**-.232****	**-.322****	**-.283****	**.266****	**-.414****
		Sig. (2-tailed)	**.001**	.296	**.001**	**.000**	**.000**	**.000**	**.000**
	Housing Estate	Pearson Correlation	.088	-.078	**-.137***	**-.269****	**-.267****	**.179****	**-.353****
		Sig. (2-tailed)	.199	.254	**.046**	**.000**	**.000**	**.009**	**.000**
	Urban Neighbourhood	Pearson Correlation	**.154***	-.068	**-.184****	**-.375****	**-.334****	**.210****	**-.435****
		Sig. (2-tailed)	**.024**	.324	**.007**	**.000**	**.000**	**.002**	**.000**

DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214.

Moreover, by comparing the mean values of the evaluations of overall residential environment using One-way Analysis of Variance, the following findings can be summarized: Firstly, the overall satisfaction of the respondents living in 2-bedroom dwelling units (3.57) were significantly lower than those of the respondents living in 3-bedroom ones (3.93); Second, the dwelling units with south orientation have a significantly higher satisfaction than those with other orientations. However, there is no significant difference between those with and without cross-ventilation; Third, the respondents whose dwelling buildings were located in the middle of the housing estates expressed significantly higher satisfaction than those living near the boundary of the estates; 4th, in terms of building form, the satisfaction of the respondents living in slab high-rise housing were significantly higher than those of the respondents living in short-slab high-rise housing, and the later were higher than those living in tower high-rise housing, but the differences were not significant; Fifth, as for the planning layout of housing estates, the respondents who lived in Case 1, Case 2, and Case 3 revealed significant higher satisfaction than those of Case 4, while there is no significant difference among the former three cases; and finally, there was a clear trend that as the household density of dwelling buildings increased, the satisfaction declined, although the difference is not statistically significant.

Table 7-7 Correlation Analysis of the Physical Features of Residential Environment and the Satisfactions with 8 Liveability Elements of Urban Neighbourhood

Satisfactions with		**DU1**	DU2	**DU3**	**DB1**	**DB2**	**DB3**	**HE**
Local Public Space	Pearson Correlation	**.185****	**-.154***	**-.323****	**-.489****	**-.484****	**.151***	**-.566****
	Sig. (2-tailed)	.007	**.024**	.000	**.000**	**.000**	**.027**	**.000**
Local Service Facilities	Pearson Correlation	.122	.032	-.056	**-.196****	**-.189****	.109	**-.265****
	Sig. (2-tailed)	.075	.642	.418	**.004**	**.006**	.113	**.000**
Noise	Pearson Correlation	**.146***	-.086	**-.227****	**-.341****	**-.337****	**.285****	**-.343****
	Sig. (2-tailed)	**.032**	.208	**.001**	**.000**	**.000**	**.000**	**.000**
Traffic Condition	Pearson Correlation	.110	-.054	**-.185****	**-.345****	**-.320****	**.243****	**-.349****
	Sig. (2-tailed)	.108	.434	**.007**	**.000**	**.000**	**.000**	**.000**
Public Transportation	Pearson Correlation	.097	-.006	**-.191****	**-.246****	**-.248****	**.191****	**-.300****
	Sig. (2-tailed)	.156	.932	**.005**	**.000**	**.000**	**.005**	**.000**
Environmental Tidiness	Pearson Correlation	.094	-.132	**-.208****	**-.325****	**-.312****	**.186****	**-.338****
	Sig. (2-tailed)	.169	.053	**.002**	**.000**	**.000**	**.006**	**.000**
Public Security Situation	Pearson Correlation	.020	-.093	**-.146***	**-.253****	**-.231****	**.142***	**-.300****
	Sig. (2-tailed)	.771	.174	**.033**	**.000**	**.001**	**.038**	**.000**
Neighbourhood Attachment	Pearson Correlation	.055	.001	**-.142***	**-.289****	**-.275****	**.153***	**-.337****
	Sig. (2-tailed)	.422	.991	**.038**	.000	.000	**.025**	.000

DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214.

Furthermore, a correlation analysis was carried out to examine the relationships between the residential environment features of the respondents and the satisfaction ratings of the 58 liveability elements. At the spatial level of urban neighbourhood, the outcomes of correlation analysis indicated that there were significant correlations between the features of dwelling buildings and the satisfaction with the 8 liveability elements (Table 7-7). The slab high-rise dwelling buildings with lower household density and central location obtained higher satisfaction. The respondents living in dwelling units with north-south orientation and cross-ventilation were more satisfied with the liveability elements of urban neighbourhood except local service facilities.

At the spatial level of housing estate, as the Table 7-8 showed, the four features: dwelling unit's orientation and ventilation, dwelling building's layout, building form and location, were significantly correlated to the satisfaction with most of liveability elements. The results of correlation analysis revealed the important principle of housing estates' planning and design – good landscape and convenient facilities were arranged around the dwelling buildings with better residential environment and higher property price, which reflected the core ideology of the market-oriented housing development. The respondents living in central locations of housing estates expressed significantly higher satisfaction with the community environment. 4 elements: pedestrian walkways, internal roads, car parking and barrier-free design that constitute the internal traffic system of housing estates together did not obtain significantly different satisfaction ratings, which indicated the allocation of traffic resource was pretty even during the planning and design process.

Table 7-8 Correlation Analysis of the Physical Features of Residential Environment and the Satisfactions with 16 Liveability Elements of Housing Estate

Satisfaction with		DU1	DU2	DU3	DB1	DB2	DB3	HE
Green Area and Landscape	Pearson Correlation	.178**	-.032	-.121	-.235**	-.216**	.156*	-.335**
	Sig. (2-tailed)	.009	.640	.077	.001	.002	.022	.000
Play Areas for Children	Pearson Correlation	.134	-.106	-.223**	-.406**	-.391**	.226**	-.540**
	Sig. (2-tailed)	.051	.121	.001	.000	.000	.001	.000
Activity Places for the Elderly	Pearson Correlation	.095	-.007	-.220**	-.387**	-.351**	.177**	-.484**
	Sig. (2-tailed)	.167	.915	.001	.000	.000	.010	.000
Pedestrian Walkways	Pearson Correlation	.153*	-.118	-.139*	-.093	-.124	.069	-.151*
	Sig. (2-tailed)	.025	.084	.042	.176	.070	.318	.027
Internal Roads	Pearson Correlation	.048	.077	-.001	-.010	-.018	-.017	-.004
	Sig. (2-tailed)	.489	.260	.993	.887	.788	.808	.951
Car Parking	Pearson Correlation	.038	.081	-.023	.046	-.007	-.030	.056
	Sig. (2-tailed)	.582	.238	.734	.508	.920	.662	.411
Internal Public Service Facilities	Pearson Correlation	.130	-.140*	-.222**	-.409**	-.387**	.229**	-.520**
	Sig. (2-tailed)	.058	.041	.001	.000	.000	.001	.000
Population Density	Pearson Correlation	.101	-.039	-.045	-.150*	-.139*	.173*	-.163*
	Sig. (2-tailed)	.141	.566	.510	.028	.042	.011	.017
Barrier-Free Designs	Pearson Correlation	.175*	-.037	-.111	-.092	-.116	.122	-.085
	Sig. (2-tailed)	.010	.594	.104	.182	.090	.075	.217
Building Density and Spacing	Pearson Correlation	.077	.029	-.088	-.257**	-.221**	.160*	-.270**
	Sig. (2-tailed)	.262	.674	.198	.000	.001	.019	.000
Outdoor Environment in Summer	Pearson Correlation	.141*	-.102	-.185**	-.311**	-.262**	.193**	-.375**
	Sig. (2-tailed)	.039	.138	.007	.000	.000	.005	.000
Outdoor Environment in Winter	Pearson Correlation	.157*	-.039	-.209**	-.368**	-.337**	.166*	-.449**
	Sig. (2-tailed)	.021	.570	.002	.000	.000	.015	.000
Wind Environment	Pearson Correlation	.173*	-.076	-.202**	-.221**	-.222**	.075	-.192**
	Sig. (2-tailed)	.011	.269	.003	.001	.001	.273	.005
Maintenance and Management	Pearson Correlation	.101	-.012	-.184**	-.248**	-.214**	.286**	-.270**
	Sig. (2-tailed)	.140	.865	.007	.000	.002	.000	.000
Community Security	Pearson Correlation	.101	-.135*	-.120	-.168*	-.178**	.121	-.241**
	Sig. (2-tailed)	.142	.049	.080	.014	.009	.078	.000
Sense of Community	Pearson Correlation	.189**	-.054	-.187**	-.261**	-.259**	.174*	-.352**
	Sig. (2-tailed)	.006	.429	.006	.000	.000	.011	.000
DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation; DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate; HE: Housing Estate (Case 1, 2, 3, and 4).								
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N=214								

At the spatial level of dwelling building, three features: dwelling building's layout, building form and location in housing estate were significantly correlated to the satisfactions of the most elements (Table 7-9). Through the comparison of mean values, it can be found that the slab high-rise housing with lower household density and better orientation and ventilation got higher satisfaction of most elements. However, because of the standardized architecture design, three elements: facade design, building identity and barrier-free design were not significantly correlated to the residential environment features. It is worth noting that the satisfaction with construction quality of dwelling buildings had significant correlation with all of the 7 features. Better residential environment means better construction quality. But the respondents living on higher floors had lower satisfaction with construction quality. As many interviewees indicated, the quality problems, such as shaking in strong wind, cracking of the wall paint, and shedding of wall tiles, were becoming more serious with increasing storey levels.

Table 7-9 Correlation Analysis of the Physical Features of Residential Environment and the Satisfactions with 16 Liveability Elements of Dwelling Building

Satisfaction with		DU1	DU2	DU3	DB1	DB2	DB3	HE
Building Form	Pearson Correlation	.106	-.010	**-.170***	**-.295****	**-.276****	.129	**-.342****
	Sig. (2-tailed)	.123	.885	**.013**	**.000**	**.000**	.060	**.000**
Building Height	Pearson Correlation	.072	-.133	**-.210****	**-.337****	**-.319****	**.142***	**-.348****
	Sig. (2-tailed)	.291	.053	**.002**	**.000**	**.000**	**.038**	**.000**
Façade Design	Pearson Correlation	**.158***	-.045	-.091	-.093	-.108	.063	**-.190****
	Sig. (2-tailed)	**.021**	.514	.185	.176	.115	.359	**.005**
Construction Quality	Pearson Correlation	**.154***	**-.173***	**-.174***	**-.285****	**-.285****	**.178****	**-.368****
	Sig. (2-tailed)	**.024**	**.011**	**.011**	**.000**	**.000**	**.009**	**.000**
Quality and Quantity of Lifts	Pearson Correlation	.118	-.108	**-.352****	**-.318****	**-.335****	**.220****	**-.378****
	Sig. (2-tailed)	.086	.116	**.000**	**.000**	**.000**	**.001**	**.000**
Communal Space Design	Pearson Correlation	.118	-.125	**-.210****	**-.257****	**-.241****	**.225****	**-.322****
	Sig. (2-tailed)	.085	.067	**.002**	**.000**	**.000**	**.001**	**.000**
Public Lighting	Pearson Correlation	.100	.004	**-.179****	**-.283****	**-.252****	**.180****	**-.302****
	Sig. (2-tailed)	.144	.953	**.009**	**.000**	**.000**	**.008**	**.000**
Public Space Ventilation	Pearson Correlation	.095	.101	-.100	**-.239****	**-.230****	**.245****	**-.236****
	Sig. (2-tailed)	.167	.143	.146	**.000**	**.001**	**.000**	**.001**
Barrier-Free Designs	Pearson Correlation	.013	-.050	.045	.038	.049	.022	.017
	Sig. (2-tailed)	.855	.467	.515	.577	.472	.748	.807
Household Density	Pearson Correlation	.059	-.021	-.110	**-.193****	**-.184****	**.138***	**-.174***
	Sig. (2-tailed)	.391	.755	.107	**.005**	**.007**	**.044**	**.011**
Upkeep of Public Facilities	Pearson Correlation	**.138***	-.030	**-.238****	**-.236****	**-.269****	**.210****	**-.223****
	Sig. (2-tailed)	**.043**	.662	**.000**	**.001**	**.000**	**.002**	**.001**
Collection of Domestic Waste	Pearson Correlation	.105	-.073	**-.193****	**-.254****	**-.259****	**.228****	**-.229****
	Sig. (2-tailed)	.125	.291	**.005**	**.000**	**.000**	**.001**	**.001**
Fire and Seismic Safety	Pearson Correlation	-.006	-.091	**-.213****	**-.286****	**-.301****	.102	**-.303****
	Sig. (2-tailed)	.935	.184	.002	**.000**	**.000**	.137	**.000**
Security in Building	Pearson Correlation	.087	-.090	-.119	**-.299****	**-.277****	.073	**-.357****
	Sig. (2-tailed)	.206	.189	.083	**.000**	**.000**	.290	**.000**
Identity of Building	Pearson Correlation	.054	.077	-.017	**-.137***	-.112	.101	**-.167***
	Sig. (2-tailed)	.434	.262	.803	**.045**	.102	.142	**.014**
Relation with Neighbours	Pearson Correlation	.070	-.112	-.096	**-.262****	**-.209****	.100	**-.283****
	Sig. (2-tailed)	.306	.102	.161	**.000**	**.002**	.146	**.000**

DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

At the spatial level of dwelling unit, five out of seven residential environment features of the respondents were significantly correlated to the majority of satisfactions (Table 7-10).

Table 7-10 Correlation Analysis of the Physical Features of Residential Environment and the Satisfactions with 18 Liveability Elements of Dwelling Unit

Satisfaction with		DU1	DU2	DU3	DB1	DB2	DB3	HE
Size	Pearson Correlation	.212**	-.061	-.177**	-.249**	-.225**	.180**	-.244**
	Sig. (2-tailed)	.002	.372	.009	.000	.001	.008	.000
Layout	Pearson Correlation	.157*	-.027	-.247**	-.185**	-.205**	.213**	-.170*
	Sig. (2-tailed)	.022	.692	.000	.007	.003	.002	.013
Storage	Pearson Correlation	.039	-.084	-.190**	-.275**	-.297**	.237**	-.235**
	Sig. (2-tailed)	.575	.219	.005	.000	.000	.000	.001
Structure Quality	Pearson Correlation	.070	-.043	-.169*	-.256**	-.288**	.166*	-.221**
	Sig. (2-tailed)	.308	.534	.013	.000	.000	.015	.001
Infrastructure	Pearson Correlation	.046	.025	-.101	-.160*	-.149*	.098	-.189**
	Sig. (2-tailed)	.506	.715	.139	.019	.029	.152	.006
Natural Lighting	Pearson Correlation	.117	.062	-.108	-.168*	-.139*	.085	-.246**
	Sig. (2-tailed)	.088	.364	.115	.014	.042	.217	.000
Natural Ventilation	Pearson Correlation	.281**	.025	-.276**	-.230**	-.190**	.208**	-.265**
	Sig. (2-tailed)	.000	.717	.000	.001	.005	.002	.000
Heating in Winter	Pearson Correlation	.062	.016	-.108	-.216**	-.186**	.231**	-.301**
	Sig. (2-tailed)	.366	.816	.114	.002	.006	.001	.000
Cooling in Summer	Pearson Correlation	.152*	-.090	-.160*	-.186**	-.187**	.157*	-.234**
	Sig. (2-tailed)	.026	.190	.019	.006	.006	.021	.001
Indoor Air Quality	Pearson Correlation	.190**	-.011	-.138*	-.199**	-.176**	.131	-.238**
	Sig. (2-tailed)	.005	.878	.044	.004	.010	.056	.000
Internal Sound-proof	Pearson Correlation	.050	-.051	-.166*	-.246**	-.258**	.209**	-.251**
	Sig. (2-tailed)	.468	.454	.015	.000	.000	.002	.000
External Sound-proof	Pearson Correlation	.143*	-.137*	-.124	-.236**	-.218**	.251**	-.234**
	Sig. (2-tailed)	.037	.045	.069	.000	.001	.000	.001
Private Outdoor Space	Pearson Correlation	.148*	-.087	-.211**	-.293**	-.295**	.180**	-.284**
	Sig. (2-tailed)	.031	.203	.002	.000	.000	.008	.000
View	Pearson Correlation	.159*	-.070	-.295**	-.389**	-.369**	.309**	-.424**
	Sig. (2-tailed)	.020	.308	.000	.000	.000	.000	.000
Privacy	Pearson Correlation	.143*	.069	-.249**	-.309**	-.327**	.259**	-.374**
	Sig. (2-tailed)	.036	.317	.000	.000	.000	.000	.000
Safety	Pearson Correlation	.107	-.150*	-.197**	-.327**	-.327**	.174*	-.407**
	Sig. (2-tailed)	.119	.028	.004	.000	.000	.011	.000
Comfort	Pearson Correlation	.081	-.055	-.160*	-.196**	-.216**	.150*	-.214**
	Sig. (2-tailed)	.236	.425	.019	.004	.001	.028	.002
Property Cost	Pearson Correlation	.121	-.075	-.194**	-.353**	-.346**	.090	-.441**
	Sig. (2-tailed)	.076	.277	.004	.000	.000	.190	.000

DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

The respondents living in bigger dwelling units with north-south orientation and natural ventilation were more satisfied with their residential environment, while the dwelling building's layout, form and location were significantly correlated to the satisfaction with the majority of liveability elements. The storey on which the dwelling unit locates did not significantly influence the satisfaction with most elements. However, the respondents living in higher floors were more dissatisfied with the external noise and sense of safety. The results revealed that, higher floors did not provide more attractive residential environment in both physical and psycho-social dimensions including spectacular view and privacy, which was inconsistent with many studies in developed countries and cities (see, Kim 1997, Liu 1999, Yuen 2011). Moreover, the location of dwelling buildings in housing estates did not have direct impact on the satisfaction of natural lighting and indoor air quality.

In the psycho-social dimension, among the six features, only length of residence was significantly correlated to satisfaction (Table 7-11). The results of One-way Analysis of Variance showed that the longer the residents have lived in their dwelling units, the more satisfied they are with their dwelling. But it is worth noting that the length of residence was significantly related to the study case which the respondents were living in. Because the majority of the residents in the study cases are first residents in their respective communities, the length of their residency was very much dictated by the length of time the estate has been completed. Further correlation analysis indicated that there were no significant correlations between the psycho-social features and the satisfactions of the most liveability elements. Generally speaking, the psycho-social features of the respondents' residential environment have weaker correlation with the satisfaction ratings than the physical features.

Table 7- 11 Correlation Analysis of the Psycho-social Features of Residential Environment and Satisfactions of the Respondents

Satisfaction with		PF1	PF2	PF3	PF4	PF5	PF6
Overall Residential Environment	Pearson Correlation	.070	**.191****	.029	-.002	-.068	-.091
	Sig. (2-tailed)	.311	**.005**	.672	.977	.319	.184
Dwelling Unit	Pearson Correlation	-.016	**.153***	-.016	-.018	.053	.036
	Sig. (2-tailed)	.812	**.025**	.818	.796	.442	.599
Dwelling Building	Pearson Correlation	-.005	**.218****	.016	.004	.048	-.068
	Sig. (2-tailed)	.945	**.001**	.822	.950	.481	.322
Housing Estate	Pearson Correlation	-.051	**.177****	.054	-.078	-.047	-.018
	Sig. (2-tailed)	.454	**.009**	.434	.257	.491	.792
Urban Neighbourhood	Pearson Correlation	-.060	**.205****	.114	-.102	-.084	-.063
	Sig. (2-tailed)	.381	**.003**	.097	.139	.220	.356

PF: Psycho-social Feature; PF1: Tenure; PF2: Length of Residence; PF3: History of High-rise Living (Whether or not formerly lived in high-rise housing); PF4: Former Housing Types; PF5: Preferred Storey; PF6: Preferred Housing Type.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

7.4 Correlation between respondents' demographical features and residential environmental features

A correlation analysis was carried out to explore the relationships among the demographic features and the residential environmental features of the respondents. As Table 7-12 indicated, education level of the respondents was significantly correlated to their gender, age, family income and life stage ($p < .001$), and the male respondents had higher education degree than the females, the younger respondents had higher education degree than the older ones, and the respondents with higher education degree had higher family income. Moreover, the result indicated that large households with more family members obtained higher family incomes.

Table 7- 12 Correlation Analysis of the Demographic Features of the Respondents

		DF1	DF2	DF3	DF4	DF5	DF6
DF1	Pearson Correlation	1	0.006	**-.222****	**-.137***	0.057	0.036
	Sig. (2-tailed)		0.928	**0.001**	**0.045**	0.405	0.597
DF2	Pearson Correlation	0.006	1	**-.386****	-0.039	-0.105	**.863****
	Sig. (2-tailed)	0.928		**0**	0.57	0.126	**0**
DF3	Pearson Correlation	**-.222****	**-.386****	1	**.383****	-0.006	**-.453****
	Sig. (2-tailed)	**0.001**	**0**		**0**	0.927	**0**
DF4	Pearson Correlation	**-.137***	-0.039	**.383****	1	**.322****	-0.051
	Sig. (2-tailed)	**0.045**	0.57	**0**		**0**	0.46
DF5	Pearson Correlation	0.057	-0.105	-0.006	**.322****	1	0.104
	Sig. (2-tailed)	0.405	0.126	0.927	**0**		0.129
DF6	Pearson Correlation	0.036	**.863****	**-.453****	-0.051	0.104	1
	Sig. (2-tailed)	0.597	**0**	**0**	0.46	0.129	
DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Level of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.							
**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N=214							

In the physical dimension, as shown in Table 7-13, it is found that there are significant correlations between the physical residential environment features. A trend can be found that larger dwelling units are more likely to have better orientation and ventilation, the dwelling units located in the middle of community are more likely to have a better residential environment than those near the boundaries, and slab dwelling buildings provided better residential environment than short-slab and tower dwelling buildings. In the psycho-social dimension, length of residence and preferred housing type of the respondents were significantly correlated to the physical features of their residential environments. The respondents with longer residency time lived in better high-rise residential environment, and the respondents who preferred other housing types lived in dwelling units with poorer environment quality.

Moreover, as Table 7-14 showed, family income and household size of the respondents were significantly correlated to the physical features of their residential environment. The results of the further analysis indicated that the respondents with higher family income and larger household size are more likely to live in larger dwelling units with better orientation and ventilation, and their dwelling buildings are more likely to have lower household density and better location in the estate. The respondents living in slab dwelling buildings had higher family income and more family members, flowed by those in short-slab and tower buildings.

To sum up, the statistical analysis in this section indicated that, respondents with higher family incomes usually enjoyed better residential environment, and more respondents with higher education levels and higher family incomes preferred high-rise living than their lower-earning counterparts with lower education levels.

Table 7- 13 Correlation Analysis of the Residential Environment Features of the Respondents

		DU1	DU2	DU3	DB1	DB2	DB3	HE	PF1	PF2	PF3	PF4	PF5	PF6
DU1	PC	1	-0.099	**-.387****	**-.213****	**-.176****	**.240****	**-.255****	0.114	**.164***	-0.045	-0.005	**-.159***	0.111
	Sig.		0.151	**0**	**0.002**	**0.01**	**0**	**0**	0.095	**0.016**	0.512	0.936	**0.02**	0.105
DU2	PC	-0.099	1	**.232****	**.304****	**.319****	-0.128	**.291****	0.048	-0.12	-0.114	**.365****	0.014	-0.011
	Sig.	0.151		**0.001**	**0**	**0**	0.062	**0**	0.489	0.08	0.096	0	0.841	0.878
DU3	PC	**-.387****	**.232****	1	**.583****	**.690****	**-.328****	**.468****	0.039	**-.227****	0.072	0.025	0.032	**-.332****
	Sig.	**0**	**0.001**		**0**	**0**	**0**	**0**	0.566	**0.001**	0.295	0.711	0.646	**0**
DB1	PC	**-.213****	**.304****	**.583****	1	**.941****	**-.359****	**.845****	0.089	**-.483****	-0.037	0.121	0.052	**-.150***
	Sig.	**0.002**	**0**	**0**		**0**	**0**	**0**	0.192	**0**	0.589	0.077	0.445	**0.028**
DB2	PC	**-.176****	**.319****	**.690****	**.941****	1	**-.346****	**.784****	0.099	**-.413****	-0.011	0.112	0.049	**-.216****
	Sig.	**0.01**	**0**	**0**	**0**		**0**	**0**	0.147	**0**	0.875	0.104	0.477	**0.002**
DB3	PC	**.240****	-0.128	**-.328****	**-.359****	**-.346****	1	**-.284****	0.102	**.247****	-0.031	0.007	-0.089	0.119
	Sig.	**0**	0.062	**0**	**0**	**0**		0	0.136	**0**	0.653	0.923	0.195	0.082
HE	PC	**-.255****	**.291****	**.468****	**.845****	**.784****	**-.284****	1	0.042	**-.553****	-0.087	0.131	0.08	-0.08
	Sig.	**0**	**0**	**0**	**0**	**0**	**0**		0.537	**0**	0.205	0.056	0.245	0.245
PF1	PC	0.114	0.048	0.039	0.089	0.099	0.102	0.042	1	**.134***	0.051	-0.032	-0.088	-0.121
	Sig.	0.095	0.489	0.566	0.192	0.147	0.136	0.537		**0.049**	0.459	0.64	0.202	0.077
PF2	PC	**.164***	-0.12	**-.227****	**-.483****	**-.413****	**.247****	**-.553****	**.134***	1	0.077	0.023	-0.058	-0.009
	Sig.	**0.016**	0.08	**0.001**	**0**	**0**	**0**	**0**	**0.049**		0.259	0.734	0.398	0.899
PF3	PC	-0.045	-0.114	0.072	-0.037	-0.011	-0.031	-0.087	0.051	0.077	1	-0.119	0.046	**-.651****
	Sig.	0.512	0.096	0.295	0.589	0.875	0.653	0.205	0.459	0.259		0.083	0.502	**0**
PF4	PC	-0.005	**.365****	0.025	0.121	0.112	0.007	0.131	-0.032	0.023	-0.119	1	0.081	0.086
	Sig.	0.936	**0**	0.711	0.077	0.104	0.923	0.056	0.64	0.734	0.083		0.237	0.21
PF5	PC	**-.159***	0.014	0.032	0.052	0.049	-0.089	0.08	-0.088	-0.058	0.046	0.081	1	-0.003
	Sig.	**0.02**	0.841	0.646	0.445	0.477	0.195	0.245	0.202	0.398	0.502	0.237		0.967
PF6	PC	0.111	-0.011	**-.332****	**-.150***	**-.216****	0.119	-0.08	-0.121	-0.009	**-.651****	0.086	-0.003	1
	Sig.	0.105	0.878	**0**	**0.028**	**0.002**	0.082	0.245	0.077	0.899	**0**	0.21	0.967	

DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).
PF: Psycho-social Feature; PF1: Tenure; PF2: Length of Residence; PF3: History of High-rise Living (Whether or not formerly lived in high-rise housing); PF4: Former Housing Types; PF5: Preferred Storey; PF6: Preferred Housing Type.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214.

Table 7- 14 Correlation Analysis of the Demographic Features and the Residential Environment Features of the Respondents

		DU1	DU2	DU3	DB1	DB2	DB3	HE	PF1	PF2	PF3	PF4	PF5	PF6
DF1	PC	-0.05	-0.018	0.064	0.038	0.049	0.054	0.035	-0.03	-0.02	0.038	-0.101	0.111	0.007
	Sig.	0.471	0.791	0.353	0.58	0.474	0.432	0.609	0.659	0.777	0.579	0.139	0.106	0.921
DF2	PC	0.001	-0.053	-0.038	-0.07	-0.055	0.133	-0.034	0.001	**.134***	**.146***	0.072	0.061	-0.081
	Sig.	0.987	0.442	0.584	0.311	0.426	0.052	0.622	0.991	**0.05**	**0.033**	0.292	0.373	0.236
DF3	PC	0.057	0.067	-0.093	-0.009	-0.062	0.068	-0.007	0.069	0.058	**-.211****	0.048	-0.083	**.187****
	Sig.	0.403	0.331	0.175	0.895	0.366	0.324	0.921	0.317	0.397	**0.002**	0.484	0.225	**0.006**
DF4	PC	**.311****	**-.140***	**-.260****	**-.291****	**-.296****	**.301****	**-.269****	-0.04	**.250****	-0.088	0.049	-0.102	**.163***
	Sig.	**0**	**0.041**	**0**	**0**	**0**	**0**	**0**	0.562	**0**	0.201	0.475	0.135	**0.017**
DF5	PC	**.312****	-0.123	**-.188****	**-.188****	**-.155***	0.1	**-.240****	0.015	0.116	0.067	-0.022	0.004	0.059
	Sig.	**0**	0.073	**0.006**	**0.006**	**0.023**	0.143	**0**	0.83	0.089	0.329	0.75	0.952	0.394
DF6	PC	0.083	-0.09	-0.072	-0.106	-0.087	0.101	-0.078	0.012	0.113	**.182****	0.034	0.037	-0.087
	Sig.	0.229	0.188	0.291	0.124	0.206	0.14	0.256	0.861	0.1	**0.008**	0.617	0.589	0.203

DF: Demographical Features; DF1: Gender; DF2: Age; DF3: Degree of Education; DF4: Family Income; DF5: Household Size; DF6: Life Stage.
DU: Dwelling Unit; DU1: Size; DU2: Storey; DU3: Orientation & Ventilation;
DB: Dwelling Building; DB1: Layout; DB2: Building Form; DB3: Location in Housing Estate;
HE: Housing Estate (Case 1, 2, 3, and 4).
PF: Psycho-social Feature; PF1: Tenure; PF2: Length of Residence; PF3: History of High-rise Living (Whether or not formerly lived in high-rise housing);
PF4: Former Housing Types; PF5: Preferred Storey; PF6: Preferred Housing Type.

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
N=214

7.5 Developing a Liveability Index (LI) for high-rise housing estates in China

In the questionnaire, the liveability assessment of high-rise housing estates consisted of three levels: satisfaction with overall residential environment, satisfactions with four spatial levels and satisfactions with 58 liveability elements. In order to find a measurement to effectively reflect the comprehensive performance of the 58 liveability elements, firstly, two Regression Analyses, respectively adopted the satisfactions with four spatial levels and the satisfactions with 58 liveability elements as independent variables, the satisfaction with overall residential environment as dependent variable, have been conducted to examine the goodness of fit of the two regression models. The results showed that the satisfaction with overall residential environment was not able to effectively explain and generalize both the variance of the satisfactions with four spatial levels and that of the satisfactions with 58 liveability elements due to the low coefficient of determination (Table 7-15, R^2 = .378 and .577). In other words, the satisfaction with overall residential environment was not an effective measurement to the comprehensive liveability evaluation of high-rise housing estates from the statistics perspective.

Table 7- 15 Comparison of the Goodness of Fit of the Three Regression Models

Model 1 Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.615[a]	.378	.366	.542
a. Dependent Variable: satisfaction with overall residential environment; Predictors: (Constant), satisfactions with four spatial levels				
Model 2 Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.760[a]	.577	.419	.519
a. Dependent Variable: satisfaction with overall residential environment; Predictors: (Constant), satisfactions with 58 liveability elements				
Model 3 Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.954[a]	.909	.875	.16857
a. Dependent Variable: the average value of satisfactions with four spatial levels; Predictors: (Constant), satisfactions with the 58 liveability elements				

And then, a Regression Analysis, the average value of satisfactions with four spatial levels as a dependent variable, and 58 liveability elements as independent variables, was carried out. The determination coefficient of the regression model reached 0.909, which indicated the average value of the satisfactions with four spatial levels was able to explain 90.9% of variance of the satisfactions with 58 liveability elements. Comparing with the satisfaction with overall residential environment, obviously, the average value of the satisfaction with four spatial levels should be a more accurate composite indicator of the liveability of high-rise housing estates. Therefore, this study adopted the average value of the satisfaction with four spatial levels as ***liveability index*** that can be calculated by using Eq. (1):

$$LI = \frac{\sum_{i=1}^{N} DUi + \sum_{i=1}^{N} DBi + \sum_{i=1}^{N} HEi + \sum_{i=1}^{N} UNi}{N \times 4} \qquad (1)$$

Where *LI* is the liveability index, *N* is the number of respondents, while *DUi, DBi, HEi,* and *UNi* represent the actual satisfaction score of the *i*th respondent with the four spatial levels: Dwelling Unit (DU), Dwelling Building (DB), Housing Estate (HE) and Urban Neighbourhood (UN).

7.6 Establishing an Indicator System for the liveability of high-rise housing estates

In order to find the key indicators for liveability of high-rise housing estates among the 58 liveability elements, a multiple linear regression analysis using stepwise method has been carried out and the backward method was adopted because of the lower risk of 'missing a predictor that does in fact predict the outcome' (Field 2005, p161).

The liveability index as dependent variable and the 58 liveability elements as independent variables, the regression model consisted of 7 variables (significant at the 0.001 level) – dwelling unit's ***structure quality*** and ***indoor air quality***, dwelling building's ***relationship with neighbours***, housing estate's ***summer outdoor environment***, ***maintenance of community***, and ***sense of community***, and urban neighbourhood's ***public space*** and ***public security*** (Table 7-16).

Table 7- 16 Regression Model of Liveability Index and Liveability Indicators

R= .912; R^2 = .832; Adjusted R^2 = .826; Std. Error of the Estimate: .19907; F (8,205) = 145.646; Significance: .000							
Model			Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		
1	(Constant)		.448	.107		4.182	**.000**
	Dwelling Unit	Structure Quality	.091	.020	.148	4.461	**.000**
		Indoor Air Quality	.174	.027	.214	6.407	**.000**
	Housing Estate	Summer Outdoor Environment	.134	.026	.184	5.061	**.000**
		Maintenance of housing estate	.138	.022	.230	6.201	**.000**
		Sense of Community	.150	.025	.226	5.985	**.000**
	Urban Neighbour-hood	Local Public Space	.090	.019	.157	4.637	**.000**
		Public Security Situation	.124	.024	.176	5.236	**.000**
Dependent Variable: Liveability Index							

The combination of the 7 liveability elements can predict 83.2% of variation of liveability index, while the difference between R^2 and the adjusted R^2 is small (0.832 - 0.826 = 0.006), which means that if the model were derived from the population rather than a sample of it, it would account for about 0.6% less variance in the outcome. As such, the model has explained quite a large amount of the variation of liveability index, and has generalized the variation very well. Moreover, the regression model significantly predicted the liveability degree of high-rise housing estates in the inner city of Tianjin, with F (7,206) = 145.646, $p < 0.001$. The standardized beta coefficients presented in Table 7-17 indicated that satisfaction with ***sense of community*** (0.230), ***maintenance of housing estate*** (0.226), ***indoor air quality*** (0.214), ***summer outdoor environment*** (0.184), and ***public security of surrounding neighbourhood*** (0.176), have greater contribution to liveability index of high-rise housing estates, followed by ***local public space*** (0.157) and ***structure quality of dwelling unit*** (0.148). These findings revealed the key liveability elements that had more significant impact on the liveability performance of high-rise housing estates, and help policy-makers, developers, planners and designers understand the significance of the elements in carrying out planning and development of high-rise housing estates.

Moreover, the regression model corroborates some of the findings of other empirical studies. For example, the results of two studies respectively in Hong Kong (Mak, Cheung et al. 2009) and Rio de Janeiro (Rio, Levi et al. 2012) confirmed that sense of community is one of the most important indicators for liveability of residential environment. Many researchers such as Henry Shaftoe (2007), Hugo Priemus (1986), Lauren Costello (2005) suggested the importance of management and maintenance of the estate for high-rise living. Different from garden houses, the study of Chau and Wang (2011) pointed out the value of indoor air quality in high-density urban areas. Of course, some of indicators found in this study are based on the specific context of Tianjin, China. Public security of neighbourhood is one of the best instances. Because the majority of housing estates are gated communities, the enclosed boundary improved the sense of safety within the estates, but deteriorated the security of their surrounding urban neighbourhood. Thus, the security situations of neighbourhood become particularly important for the liveability of high-rise housing estates. Another example is summer outdoor environment. The reason why summer outdoor environment is so important for the liveability of high-rise housing estates is that the summer is the main season of outdoor activities for the most residents under the climate of Tianjin. Consequently, the respondents paid more attention to the outdoor environmental quality of housing estates in summer.

7.7 Extracting the principal components of the liveability of high-rise housing estates

As the literature review showed in Chapter 2, there existed different opinions on the dimensions of liveability in various research disciplines and research objects (see, Heylen 2006, Leby and Hashim 2010, Yuen 2011). This study adopted a Principal Component Analysis (PCA) on the 58 liveability elements with varimax rotation in order to reduce the number of variables and explore the dimensions of liveability of high-rise housing estates. The Kaiser–Meyer–Olkin measure verified the sampling adequacy for the analysis, KMO = 0.915 ('superb' according to Field 2005), and all KMO values for individual items were > 0.831, which is well above the acceptable limit of 0.5 (Field 2005). Bartlett's test of sphericity $\chi^2 = 7015.318$, $p < 0.001$, indicated that correlations between items were sufficiently large for PCA. An initial analysis was run to obtain eigenvalues for each component in the data. Twelve components had eigenvalues over Kaiser's criterion of 1 and in combination explained 67.457% of the variance. Given the large sample size, and the Kaiser's criterion on twelve components, this is the number of components that were retained in the final analysis. As for the variables in components, typically, researchers take a loading of an absolute value of more than 0.3 to be important (Field 2005). Steven (2002) produced a table of critical values against which loadings can be compared. To summarize, he recommends that for a sample size of 50 a loading of 0.722 can be considered significant, for 100 the loading should be greater than 0.512, for 200 it should be greater than 0.364, for 300 it should be greater than 0.298, for 600 it should be greater than 0.21, and for 1000 it should be greater than 0.162. Therefore, based on the sample size of 214, this study adopted 0.364 as the criterion to determine the liveability elements (variables) in each component. Table 7-17 shows the component loadings after rotation. The items that cluster on the same components suggest that component 1 represents ***management and maintenance,*** component 2 ***internal environment and facilities of housing estate***, component 3 ***psychological environment of dwelling unit***, component 4 ***traffic system of housing estate***, component 5 ***surrounding neighbourhood environment***, component 6 ***communal spaces and facilities of dwelling building***, component 7 ***acoustical environment***, component 8 ***appearance of dwelling building***, component 9 ***physical environment of dwelling unit***, component 10 ***support system of dwelling unit***, component 11 ***micro-climate environment***, and component 12 ***social environment***.

The twelve components included all of the 58 liveability elements (Table 7-17). Component 1 consisted of 7 liveability elements that were related to the security management and maintenance of public spaces and facilities including all of the four spatial levels from urban neighbourhood, housing estate, dwelling building and dwelling unit. In fact, these service elements were provided by property management companies and local authorities.

Component 2 included 5 liveability elements that contributed to the internal environment of housing estates. It was worth noting that *housing cost* had a large component loading, which revealed the significant correlation between the level of service charge and the environmental quality of housing estate. In other words, the better landscape and leisure facilities housing estate provided, the higher maintenance cost residents paid.

Component 3 comprised of 5 liveability elements relating to the psychological environment of dwelling unit, and it not only included privacy, sense of safety, perceived comfort, and view, but also included residents' subjective perception of indoor air quality.

Component 4 involved 7 elements, and 5 out of which constituted the traffic system of housing estate, with 2 being the determinants of traffic loading: population density of housing estate and household density of dwelling building.

Component 5 consisted of 6 elements that defined the liveability of the surrounding urban neighbourhood. The residents' attachment of neighbourhood had a large component loading. Two elements: noise pollution and public security of urban neighbourhood were not included in this component. The former was attributable to Component 7 (Acoustic environment), and the latter belonged to the Component 1 (Management and Maintenance) due to the nature of public service and management provided by the local governments.

Component 6 focused on the communal spaces and facilities of dwelling building, and included 4 elements.

Component 7 included 5 elements that were related to the acoustic environment from the surrounding neighbourhood to internal sound-proof. As analysed in *Section 6.4.4*, wind environment and balcony (private outdoor space) were the important two impact factors relating to one of the main noise pollution of high-rise housing estates: wind noise.

Component 8 consisted of 5 elements that were focused on the appearance of dwelling building including building form, height, facade design, identify and construction quality.

Component 9 represented the physical environment of dwelling unit, and comprised of 4 elements: dwelling unit's size, layout, storage and structure quality.

Component 10 was the support system of dwelling unit such as infrastructure, indoor cooling and heating system. In the hot-summer and cold-winter climate of Tianjin, the urban central heating system has been established, and the household air conditioning system have been widely used. The position and form of air conditioner outdoor unit bits have become an important issue of architecture design.

Component 11 consisted of 5 elements that were related to the micro-climate environment of high-rise housing estates. The 5 elements were closely correlated with each other from natural lighting and ventilation, building density and spacing, to summer and winter outdoor environment of housing estate.

Finally, Component 12 was social environment consisting of relations with neighbours and sense of community.

Table 7- 17 Principle Component Analysis of the 58 Liveability Elements

Component	Component Label	Variables in Component	Component Loading
C1	Management and maintenance	Security within Dwelling Building	.661
		Upkeep of Dwelling Building	.649
		Security Management of Housing Estate	.645
		Collection of Domestic Waste	.644
		Fire and Seismic Safety of Dwelling Building	.637
		Maintenance of Housing Estate	.548
		Public Security of Urban Neighbourhood	.409
C2	Internal Environment and Facilities of Housing Estate	Play Area for Children	.748
		Activity Places for the Elderly	.707
		Green Area and Landscape	.575
		Community Public Facilities	.548
		Property Cost	.533
C3	Psychological Environment of Dwelling Unit	Privacy	.760
		Perceived Comfort	.598
		Sense of Safety	.581
		Indoor Air Quality	.560
		View	.438
C4	Traffic System of Housing Estate	Internal Roads of Housing Estate	.726
		Car & Bike Parking of Housing Estate	.696
		Accessibility within Housing Estate	.681
		Barrier-free Design of Dwelling Building	.532
		Pedestrian Walkways of Housing Estate	.513
		Population Density of Housing Estate	.432
		Household Density of Dwelling Building	.400
C5	Surrounding Neighbourhood Environment	Public Transportation	.667
		Local Public Service Faculties	.609
		Attachment of Neighbourhood	.577
		Local Public Space	.514
		Traffic Situation	.479
		Environmental Tidiness	.386
C6	Communal Spaces and Facilities of Dwelling Building	Public Lighting	.722
		Public Ventilation	.600
		Communal Space Design	.597
		Quality and Quantity of Lift	.514
C7	Acoustical Environment	External Sound-proof	.704
		Private Outdoor Space	.464
		Noise of Neighbourhood	.441
		Wind Environment of Housing Estate	.399
		Internal Sound-proof	.381
C8	Appearance of Dwelling Building	Building Height	.754
		Identity of Dwelling Building	.651
		Building Form	.638
		Building Façade Design	.637
		Construction Quality	.377
C9	Physical	Storage Space	.723
		Layout of Dwelling Unit	.615

	Environment of Dwelling Unit	Size of Dwelling Unit	.571
		Structure Quality	.483
C10	Support System of Dwelling Unit	Infrastructure	.798
		Heating in Winter	.584
		Cooling in Summer	.402
C11	Micro-Climate Environment	Natural Lighting	.657
		Building Density and Spacing	.615
		Winter Outdoor Environment	.457
		Natural Ventilation	.381
		Summer Outdoor Environment	.376
C12	Social Environment	Relationship with Neighbours	.711
		Sense of Community	.393
Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .915 Bartlett's Test of Sphericity = 7015.318 Significance = .000			

In SPSS, the twelve components had respective scores and were saved as new variables. Then, a Principal Component Regression (PCR) using stepwise method is carried out on the twelve components generated in Table 7-17 against the variable, '***liveability index***' that is the comprehensive liveability indicator as analysed in *Section 7.5*. The multiple regression analysis produces the following model in Table 7-18.

Table 7- 18 Regression Model of Liveability Index and Principal Components

R= .899; R^2 = .808; Adjusted R^2 = .797; Std. Error of the Estimate: .21530; F (12,201) = 70.556; Significance: .000						
Model		Unstandardized Coefficients		***Standardized Coefficients***	t	***Sig.***
		B	Std. Error	***Beta***		
1	(Constant)	3.652	.015		248.128	***.000***
	C1	.180	.015	***.378***	12.220	***.000***
	C2	.175	.015	***.366***	11.838	***.000***
	C3	.148	.015	***.311***	10.064	***.000***
	C4	.125	.015	***.261***	8.448	***.000***
	C5	.153	.015	***.321***	10.397	***.000***
	C6	.119	.015	***.249***	8.056	***.000***
	C7	.118	.015	***.247***	7.987	***.000***
	C8	.064	.015	***.134***	4.322	***.000***
	C9	.096	.015	***.201***	6.507	***.000***
	C10	.093	.015	***.194***	6.290	***.000***
	C11	.075	.015	***.156***	5.056	***.000***
	C12	.069	.015	***.144***	4.652	***.000***
Dependent Variable: Liveability Index; Independent Variables: Twelve Principal Components.						

The regression model is useful in identifying the major dimensions of liveability of high-rise housing estates and can be incorporated into the housing system in order to help professionals understand the constitution of liveability. Moreover, according to the standardized coefficients of beta, ***Management and Maintenance*** (0.378) has the largest contribution to the comprehensive liveability of high-rise housing estates, followed by ***Internal Environment and Facilities of Housing Estate*** (0.366), ***Surrounding Neighbourhood Environment*** (0.321), ***Psychological Environment of***

Dwelling Unit (0.311), ***Traffic System and Population Density of Housing Estates*** (0.261), ***Communal Spaces and Facilities of Dwelling Building*** (0.249), ***Acoustical Environment*** (0.247), ***Physical Environment of Dwelling Unit*** (0.201), ***Support System of Dwelling Unit*** (0.194), ***Micro-Climate Environment*** (0.156), ***Social Environment*** (0.144), and ***Appearance of Dwelling Building*** (0.134). They all have a significantly positive correlation with liveability index ($p < .001$).

7.8 Conclusion

This chapter has achieved the fourth research objective:

> *To dissect the important theoretical issues on liveability of high-rise housing estates, find out the measurement method, establish the indicator system and summarize the dimensions to develop the liveability theory of high-rise housing.*

Firstly, based on the correlation analysis between liveability evaluation and the respondents' demographic features and residential environment features, an important conclusion has been achieved: ***higher family income the respondents had, better residential environment they enjoyed, and higher liveability evaluation they expressed.*** Different from the findings of many studies in the western countries, life stage of the respondents did not significantly related to the liveability evaluation; ***there was no significantly difference of liveability evaluation between the residents with small children and those without small children.***

Secondly, the outcomes of regression analysis revealed that ***the average value of the satisfactions with the four spatial levels*** was able to explain and generalize the 58 liveability elements very well, thus it was defined as ***Liveability Index*** to indicate the comprehensive liveability evaluation of high-rise housing estates. In other words, collection of residents' satisfactions with the four spatial levels: *dwelling unit, dwelling building, housing estate* and *urban neighbourhood* is able to provide effective measurement to the liveability performance of high-rise housing estates.

Thirdly, the liveability index as dependent variable and the 58 liveability elements as independent variables, the regression analysis was carried out and extracted 7 variables – dwelling unit's ***structure quality,*** and ***indoor air quality***, housing estate's ***summer outdoor environment***, ***maintenance of community***, and ***sense of community***, and urban neighbourhood's ***public space*** and ***public security***. These findings revealed the key indicators of liveability of high-rise housing estates, and help policy-makers, developers, planners and designers understand the significance of the 7 liveability elements in carrying out planning and development of high-rise housing estates.

Fourth, a principal component analysis of the 58 liveability elements was conducted in order to define the dimensions of liveability of high-rise housing estates, 12 components were extracted, and they were: component 1 ***management and maintenance,*** component 2 ***internal environment and facilities of housing estate***, component 3 ***psychological environment of dwelling unit***, component 4 ***traffic system and population density of housing estate***, component 5 ***surrounding neighbourhood environment***, component 6 ***communal spaces and facilities of dwelling building***, component 7 ***acoustical environment***, component 8 ***appearance of dwelling building***, component 9 ***physical environment of dwelling unit***, component 10 ***support system of dwelling unit***, component 11 ***micro-climate environment***, and component 12 ***social environment***. These dimensions not only clearly defined the content of the liveability of high-rise housing estates, but also provided a comprehensive framework to improve the liveability of high-rise housing estates and achieve the liveable high-rise housing estates.

Chapter eight

Conclusions, recommendations, limitations and future works

8.1 Introduction

This chapter concludes all the findings in this research and answers the research questions raised. It then makes recommendations for future high-rise housing development in terms of planning, design and policy interventions. Finally, the limitations of this study are explained with suggestions for further research themes.

8.2 Conclusions

As discoursed in *Chapter 1*, the aim of this research is:

> '***to provide an empirical study on the liveability of the existing high-rise housing estates in China in order to inform practical development of high-rise housing estates, and make theoretical contribution to the research on the liveability of high-rise housing estates.'***

The findings of this study are thus arranged into two sections, i.e. practical implications and theoretical explorations.

8.2.1 Practical implications of liveability study on high-rise housing estates in Tianjin

1. ***Macro-context and the liveability of high-rise housing estates***

Reflecting from the decline of the numerous high-rise housing estates built after the Second World War, two different development strategies were adopted to improve the liveability of high-rise housing in different macro-contexts:

1) in the cities of Europe, America and Australia where high-rise housing was one option among the diversified housing types, high-rise housing estates were usually purpose-built in attractive locations for special social groups such as students, fashion white-collar workers or wealthy elderly, and correspondently, the planning and design of high-rise residential environment focused on the demands and features of these special groups;
2) in the Asian high-density cities including Hong Kong and Singapore where high-rise housing was the only option for the majority of families, high-rise housing estates were comprehensively planned, user-friendly designed, high-quality constructed, professionally managed and carefully maintained in order to provide the liveable residential environment that would satisfy the various needs of all kinds of families, support high-quality living, and continue to be improved through life cycle.

While viewed with caution in many countries, high-rise housing has been enthusiastically embraced in China's new urban regeneration and is quickly becoming a dominant housing form considered ideal for both reducing housing shortage and creating positive urban image.

The combination of majority high-density housing form and a majority housing provision based on private-sector commercial housing development, is the main characteristic of China's high-rise housing that is different from its counterparts in Hong Kong/Singapore and Europe/America. It demonstrates a peculiar combination of the majority high density built form copied from Hong Kong and Singapore but developed by predominantly the private sector with a market-oriented and profit-driven development pattern that seems to be copying Europe and America.

What is missing in China's high-rise housing development is the recognition that, continuous improvement based on public investment has allowed for high living satisfaction in Hong Kong/Singapore; while the variety of housing forms in Europe/America means that high-rise living is just one option among many housing choices made with free will.

In China, although high-rise is not the only housing option, the huge contrast between this and other existing housing forms (e.g. old court-yard houses, Soviet-style former work-unit housing), in terms of building condition and environmental quality, has left the emerging middle-class with few choice other than high-rises for living improvement. Driven by a desire for life improvement, a large urban population were almost forced without distinguish into choosing living off-ground. The lack of control over one's living environment and the lack of continued funding based on public interests put potential threats on the continued liveability of current high-rise housing estates in China.

Based on empirical evidence, this study has found that, the general satisfaction on the liveability of existing inner-city high-rise housing estates is high (***Liveability Index*** = 3.65 at a five-point Likert scale) in the studied area. It also found that, the vast majority of respondents (72.4%) prefer low-rise housing forms over high-rise. The apparent contradiction suggests that: firstly, housing satisfaction may not be a representation of housing preference; and secondly, there may still be a danger of decline in current satisfactory high-rise estates once other forms of housing become available.

Apart from the above analysed main characteristic, high-rise housing estates in North China also show many specific characteristics that set them apart from high-rise housing forms in other countries. Firstly, the development of high-rise housing estates is almost exclusively in the form of gated communities that enclose a large area and necessitates the demolition of existing urban neighbourhoods. Secondly, the planning layout of buildings in the estates is dictated by a calculated balance between maximized development intensity (profit) and planning requirement based on the insolation interval. Thirdly, the design of dwelling units and building layout emphasize optimized north-south orientation with cross ventilation.

Based on the above characteristics, four design typologies of high-rise housing estates emerged:

1) *majority slab high-rise housing estate;*
2) *mixed slab and short-slab high-rise housing estate;*
3) *majority short-slab high-rise housing estate;*
4) *mixed short-slab and tower high-rise housing estate.*

2. *Liveability weaknesses of high-rise housing estates in Tianjin*

Contrary to the findings in other studies (Jephcott & Robinson, 1971; McDonald & Brownlee, 1993) on high-rise liveability, which indicated lower satisfaction with families with small children, this study has found that, families with small children did not show significantly lower satisfaction with high-rise housing than households at other life stages, and that there is no significant correlation between household types (defined as life stage in this study) and liveability evaluation. However, it was also identified that, the lack of both private and public outdoor activity spaces for children and the elderly was considered one of the main weaknesses of current high-rise housing. It is therefore concluded that, despite apparently suffering from the inherent shortcomings of high density residential environment, high-rise living is considered acceptable for households at all life stages in China.

Consistent with findings in other contexts (Adams, 1992; Mesch & Manor, 1998), feeling of lack of security was identified as a main concern at the dwelling building level in this study. At other spatial levels, however, security concern was not identified as a main problem. The form of gated community with 24hr surveillance in the study cases may have played a key role in reducing the fear of crime in the estate and the neighbourhood. At the building level, however, as claimed by other research (Newman 1973), long hallways and entrances used by large number of people make it difficult for residents to identify loiterers who shielded from view may commit criminal acts. It is therefore concluded that, the form of high-rise building is found to give rise to security concerns, while good community surveillance may serve to mediate fears of crime.

Different from findings in other research (Haber, 1977; Zuckerman, Miserandino, & Bernieri 1983), which considered the association of the fear of safety (such as fire and failures of services and building structure) with high-rise housing, the survey of this study did not identify safety issues as main concerns in the high-rise housing estates studied. In fact, high-rise buildings are generally considered, in China, to be better in earthquake proof and fire safety than other housing forms. Further, as most high-rise residential buildings are less than 10-years old, problems of service and structure failures have not emerged that would lead to significant concerns. It is thus concluded that, the form of high-rise building has not been found to give rise to fear of safety in high-rise residents in China.

Contradictory to other research, which found a tendency of the weakening of social relations in high-rise housing neighbourhoods, social relations was not identified as an issue of concern in the surveys carried out in this study. As analysed in Chapter Six, the three elements that were considered indicators of social relations in housing, i.e. neighbour relations, neighbourhood attachment and sense of community have all received high satisfaction ratings in all cases studied. As discussed in Chapter Four, the long history of collective living of Chinese urban residents and the general acceptance of high density living forms and shared usage of public facilities may have contributed to the sustaining of good neighbour relations and community bonds. It is therefore concluded that, there is no evidence to show a weakening of social relations in the studied high-rise housing estates in China.

Furthermore, this study has also identified problems of high-rise housing estates, which have not been documented in studies based on other contexts than China. These are: ***poor acoustic environment*** (noise of urban neighbourhood, external and internal sound-proof of dwelling unit), ***harsh wind environment in high-rise housing estate, shortage of public places and facilities within housing estate, poor identity of***

dwelling building, shortage of auxiliary spaces of dwelling unit and poor affordability.

These problems are considered to be essentially derived from the combination of the profit-oriented high-intensity development pattern and the high-rise housing form *per se*. For example, there is a contradiction between the need for natural ventilation and external noise pollution, especially for households at higher floors, where no easy reduction measure such as plantation can be applied. The noise problem is further exacerbated by the on-going regeneration projects and is, in fact, unavoidable in most high-density Chinese inner-cities where jobs and public services concentrate.

Meanwhile, high-rise residents have also had to suffer from internal noises that come from communal facilities including lifts, water supply and drainage system. Moreover, the pursuit of maximized profit resulted in the monotonous and standardized planning and design in order to minimize construction cost, which inevitably caused the poor identity of buildings, the shortage of auxiliary spaces and the lack of public spaces and facilities. The inherent higher construction cost of high-rise buildings compared with other housing types further promoted developers to seek ways to reduce cost. Finally, high-rise housing is usually more expensive to manage and maintain, which leads to high property cost in life-cycle usage.

3. Liveability strengths of high-rise housing estates in Tianjin

The main strengths of high-rise housing in the general liveability literature have identified such elements as privacy, public green areas, good view and quietness. By comparison, this study has found that public green areas was considered to be one of the main strengths with high-rise housing in Tianjin, while no evidence has been found in this study that would support the conclusion that privacy, view and quietness are main liveability strengths. In terms of privacy, the sharing of communal spaces at all spatial levels and the found poor sound proofing between dwelling units have compromised the feeling of privacy. In terms of window views from dwelling units, the survey result shows varied opinions which indicate an uneven resource allocation with centrally-located larger flats enjoying better views than smaller flats in the outer perimeters. In terms of quietness, opposing finding was obtained to other liveability studies in that noise (both coming from indoor and outdoor) was identified as a major weakness.

This study has also identified some specific strengths with high-rise housing estates in China that have not been documented elsewhere. These include: ***comfortable indoor environment of dwelling units with high standard infrastructure, natural lighting and ventilation***. As the newest housing type with high density, the basic infrastructure including water supply system, drainage system, power system, urban central heating system, and so on, have reached high standards in the current inner-city developments. Moreover, the common pattern of planning layout of high-rise housing estates with north-south orientated high-rise buildings arranged in parallel effectively ensures natural lighting and ventilation for the majority of dwelling units. In addition, almost all dwelling units were decorated by the property-owners themselves according to their own taste, design and budget, which further improved the comfort of the indoor environment. Benefiting from the cheap labour cost, domestic wastes are collected everyday by special workers of the property companies. All of these elements together produced the comfortable indoor environment of high-rise dwelling units.

4. Implications for the planning and design of high-rise housing estates

This study has adopted a research structure that addressed the liveability issues of high-rise housing estates at four spatial levels, i.e. urban neighbourhood, housing estate, dwelling building and dwelling unit. By comparing the liveability evaluations among the four study cases at these four spatial levels, the implications for the planning and design of future high-rise housing can be revealed:

1) Dwelling unit

It is found that, dwelling units located in different building forms with varied household densities and different locations in the housing estate enjoy different sense of privacy, safety, view and indoor environment. Generally speaking, ***high-rise***

dwelling units can achieve liveable indoor environment by means of good design and decoration, while it is difficult to provide the same level of liveability to all dwelling units due to the deficiency brought about by the high density built form and uneven resource allocation inherent to the form of high-rise buildings.

2) Dwelling building

In the studied high-rise estates, the different combinations of building forms including slab, short-slab and tower buildings not only directly influenced the development intensity of housing estates, but also constructed various residential environments with different household densities and dwelling units. Indoor communal spaces such as lobby, corridor and stairwell should be careful designed, elaborately decorated and maintained in order to ensure comfort and safety and promote social interact. The quality of construction and public facilities including lighting, intercom system and lift should be guaranteed to meet the use of high intensity. To sum up, this study has found that, ***the combination of slab and short-slab dwelling buildings with high-quality communal spaces, facilities and management help form a liveable collective environment.***

3) Housing estate

It is found that, moderate development intensity, diversified building forms and flexible layout can form a richer and more liveable built environment. Benefiting from the large building spacing between high-rise dwelling buildings, high-rise housing estates can provide large public spaces and green areas, with performance influenced by the quality of landscape design and maintenance. Within the gated community, the pedestrian-vehicle-separated traffic system with ample car parking spaces can effectively improve the internal environment quality; the quality of property management and community maintenance can impact the liveability performance of housing estates. Above all, ***appropriate development intensity, people-centred planning, high-quality landscape and careful management can achieve more liveable high-rise communities***.

4) Urban neighbourhood

This study has found that, the level of maturity of the surrounding neighbourhood has an impact on the liveability of high-rise housing estates in the inner-city of Tianjin. A mature neighbourhood generally brings about more convenient public service facilities and better use of local public spaces, while a neighbourhood under regeneration would mean more noise and pollution from on-going constructions, interrupted traffic flows and deteriorated public security. With the increasing high-intensity regeneration, although local public service facilities and public transportation could be effectively improved, public spaces such as urban park and square could be compromised due to the huge demand of urban construction land by large-scale high-rise developments. This points to the fact that there lacks a comprehensive planning and urban design guidance in response to high-intensity and high-density urban development pattern in the current urban management system of Chinese cities. Meanwhile, due to the inherent disadvantage of high density urban environment, problems of noise, traffic congestion and poor environmental tidiness have been revealed in all studied cases. As an emerging housing form in Chinese metropolitans, high-rise housing estates inevitably bring about significant impact on exiting urban landscape and neighbourhoods. ***The long-term liveability of high-rise neighbourhoods would depend on a comprehensive and integrated planning and design intervention at the levels of urban neighbourhood and housing estates.***

8.2.2 Theoretical explorations of the liveability of high-rise housing estates

The theoretical explorations of this study can be summarized into four aspects:

Firstly, the relationships between residents' demographic features, residential environment features and their liveability evaluation have been revealed. Through the correlation analysis, it can be found that:

1) ***Family income*** was found to be the only demographic feature significantly correlated to liveability evaluation, and higher family incomes are associated with higher satisfactions;
2) Five residential environment features of the respondents, including dwelling unit's ***size***, ***orientation and ventilation***, dwelling building's ***layout***, ***building form*** and ***location in housing estate*** were found to be significantly correlated to liveability evaluation.
3) Significant correlation is found between respondents' ***family income*** and ***residential environment features***, with higher income families enjoying better residential environment.

In a high density development, a limited amount of environmental resources are shared by a large population, due to the differences in dwelling size, orientation, layout, building form and location, uneven allocation of resource is almost inevitable. Hence, the property price has become the tool for resource allocation. On the other hand, ***'the Matthew effect'*** of housing planning and design to meet the market-oriented housing development has emerged in China. The expensive large dwelling units with three or four bedrooms are usually planned in central locations of the estate, enjoying lower household density, quiet environment and attractive landscape; on the contrary, the small dwelling units are usually arranged in the dwelling buildings with high household density and poor orientation on the boundaries of housing estates. The phenomenon where 'the rich get richer and the poor get poorer' was consistent with the actual situations of high-rise housing estates in the inner city of Tianjin where the rich enjoy more liveable environment and the poor are disadvantaged in the competition for resource.

Secondly, a comprehensive measurement method: ***Liveability Index***, which was the average value of the satisfactions with the four spatial levels (urban neighbourhood, housing estate, dwelling building and dwelling unit), has been proposed in this study. It is found that, this index is effective in explaining and generalizing the 58 liveability elements, and collection of residents' satisfactions with the four spatial levels: *dwelling unit*, *dwelling building*, *housing estate* and *urban neighbourhood* is able to provide accurate measurement to the liveability performance of high-rise housing estates.

Thirdly, an indicator system including 7 liveability elements: dwelling unit's ***structure quality,*** and ***indoor air quality***, housing estate's ***summer outdoor environment***, ***maintenance of community***, and ***sense of community***, and urban neighbourhood's ***public space*** and ***public security***.**,** has been established to predict the liveability performance of high-rise housing estates.

Finally, 12 dimensions consisting of ***management and maintenance, internal environment and facilities of housing estate***, ***psychological environment of dwelling unit***, ***traffic system of housing estate***, ***surrounding neighbourhood environment***, ***communal spaces and facilities of dwelling building***, ***acoustical environment***, ***appearance of dwelling building***, ***physical environment of dwelling unit***, ***support system of dwelling unit***, ***micro-climate environment***, and ***social environment*** have been extracted from the 58 liveability elements, and they are able to not only clearly define the content of the liveability of high-rise housing estates, but also provide a comprehensive framework to improve the liveability of high-rise housing estates and achieve the liveable high-rise housing estates.

8.2.3 Theoretical contributions of the empirical study in Tianjin, China

In Chapter 2, two research gaps were identified in the literature on the liveability of high-rise housing estates:

1. the lack of a resident-centred theoretical framework;

2. the scarcity of research in the context of China.

This study focused on filling these two gaps, which were the main theoretical contributions.

On the one hand, the resident-centred theoretical framework -- integrating the residents' qualitative experience and quantitative evaluation on the liveability model consisting of the 4 spatial levels and 58 liveability elements, and analysing the influence of the macro-contextual features, the residents' demographic features and residential environmental features on their experience and evaluation – has been developed and examined in this study. Firstly, the analysis of the macro-context constructed the detailed research background to interpret and understand the findings of liveability survey; Secondly, as the non-professionals, the majority of the residents and the managers of property management companies who participated in the study were able to understand the liveability model very well during the whole process of site survey, which provided the solid foundation to obtain accurate information and proved the validation of the model from the perspective of methodology; Thirdly, the results of data analysis of questionnaire survey provided the strong evidence to prove the validation of the model from the perspectives of statistics; Last but not least, the combination of the qualitative and quantitative survey indeed provided a more comprehensive outcomes and conclusions on the liveability of high-rise housing estates than the existing literatures that adopted only one kind of research approaches.

On the other hand, the empirical study in the context of China provided some evidence that supported or opposed previous findings, and obtained some new findings and reached some new conclusions that had not been argued in the existing literature.

In terms of liveability weaknesses, contrary to the findings in other studies (Jephcott & Robinson, 1971; McDonald & Brownlee, 1993) on high-rise liveability, which indicated lower satisfaction with families with small children, this study in the Chinese context has found that, families with small children did not show significantly lower satisfaction with high-rise housing than households at other life stages, and that there is no significant correlation between household types (defined as life stage in this study) and liveability evaluation. However, it was also identified that, the lack of both private and public outdoor activity spaces for children and the elderly was considered one of the main weaknesses of current high-rise housing. It is therefore concluded that, despite apparently suffering from the inherent shortcomings of high-density residential environment, high-rise living is considered acceptable for households at all life stages in China.

Consistent with findings in other contexts (Adams, 1992; Mesch & Manor, 1998), feeling of lack of security was identified as a main concern at the dwelling building level in this study. At other spatial levels, however, security concern was not identified as a main problem. The form of gated community with 24hr surveillance in the study cases may have played a key role in reducing the fear of crime in the estate and the neighbourhood. At the building level, however, as claimed by other research (Newman 1973), long hallways and entrances used by a large number of people make it difficult for residents to guard against for potential criminal acts from loiterers due to shielded views. It is therefore concluded that, the form of high-rise building is found to give rise to security concerns, while good community surveillance may serve to mediate fears of crime.

Different from findings in other research (Haber, 1977; Zuckerman, Miserandino, & Bernieri 1983), which considered the association of the fear of safety (such as fire and failures of services and building structure) with high-rise housing, this study did not identify safety issues as main concerns in the high-rise housing estates studied. In fact, high-rise buildings are generally considered, in China, to be better in earthquake proof and fire safety than other housing forms. Further, as most high-rise residential buildings are less than 10-years old, problems of service and structure failures have not emerged that would lead to significant concerns. It is thus concluded that, the form of high-rise building has not been found to give rise to fear of safety in high-rise residents in China.

Contradictory to other research, which found a tendency of the weakening of social relations in high-rise housing neighbourhoods, social relations was not identified as an issue of concern in the surveys carried out in this study. As analysed in Chapter Six, the three elements that were considered indicators of social relations in housing, i.e. neighbour relations, neighbourhood attachment and sense of community have all received high satisfaction ratings in all cases studied. As discussed in Chapter Four, the long history of collective living of Chinese urban residents and the general acceptance of high density living forms and shared usage of public facilities may have contributed to the sustaining of good neighbour relations and community bonds. It is therefore concluded that, there is no evidence to show a weakening of social relations in the studied high-rise housing estates in China.

Finally, probably due to the short history of high-rise housing in China, health problems of high-rise residents have not been proposed by the respondents surveyed.

In terms of liveability strengths, the main strengths of high-rise housing in the general liveability literature have identified such elements as privacy, public green areas, good view and quietness. By comparison, this study has found that public green areas was considered to be one of the main strengths with high-rise housing in Tianjin, while no evidence has been found in this study that would support the conclusion that privacy, view and quietness are main liveability strengths. In terms of privacy, the sharing of communal spaces at all spatial levels and the found poor sound proofing between dwelling units have compromised the feeling of privacy. In terms of window views from dwelling units, the survey result shows varied opinions which indicate an uneven resource allocation with centrally-located larger flats enjoying better views than smaller flats in the outer perimeters. In terms of quietness, opposing finding was obtained to other liveability studies in that noise (both coming from indoor and outdoor) was identified as a major weakness.

8.3 Recommendations for future high-rise housing development in China

As Guido Francescato, et al (1987) pointed out, housing, in nature, should be a dynamic system which is existing in the specific macro-context and consists of a set of components, not only including residential environment, but also including the stakeholders such as residents, developers, social organizations, governments, planners and designers (Figure 8-1). According to the systems approach of Churchman (1968), objectives and performance of the system should be determined by the 'customers' of the system, that is, those who are to be served by the system. There is no doubt that residents are the customers of the housing system. Correspondingly, the main aim of a housing system should be to provide the liveable residential environment for residents in a life-cycle process, and the evaluation of a housing system should be based on residents' experiences and satisfaction of residential environment.

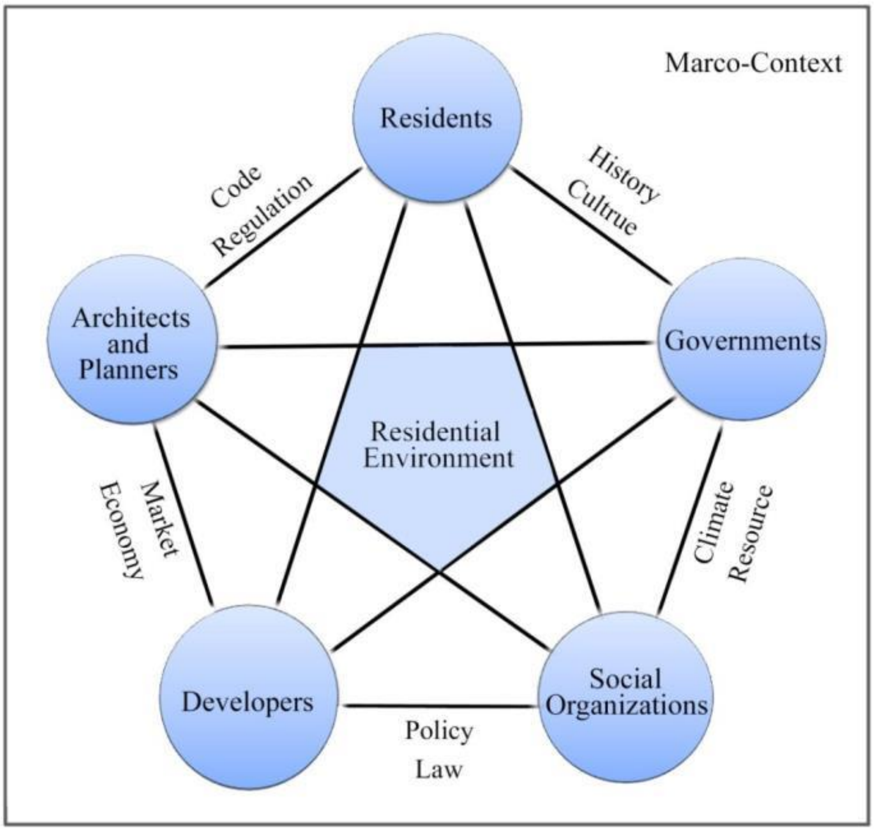


Figure 8- 1 Conceptual Framework of Housing System

Source: compiled from the book: Housing and Neighbourhoods: Theoretical and Empirical Contributions (Francescato, Weidemann et al. 1987)

In the current macro-context of China, governments and developers co-led the mass development of high-rise housing estates accompanying the rapid rise of the real estate market. This study has found that, many liveability problems derived from the profit-driven housing development pattern that mainly focused on development intensity, while largely overlooking residential environment quality. More importantly, during the whole process of urban housing development, residents --'the customer of housing system', have not been paid enough attention to, especially for the elderly and children. Therefore, ***in order to ensure the liveability of future high-rise housing estates, it is necessary to establish a resident-centred comprehensive housing development system to guarantee the quality of planning, design, construction and management***.

In this study, the varied liveability performances of the four study cases indicated that higher development intensity leads to poorer liveability, while high-quality design and management would effectively improve liveability performance of high-rise residential environment. Accordingly, on the one hand, ***the development intensity of future high-rise housing estates needs to be carefully examined, especially their impact on the urban neighbourhood should be fully analysed***; on the other hand, ***detailed planning regulations and design codes should be developed, improved and refined in order to guide site planning and management of housing estate, architecture design and maintenance of dwelling building, and interior design and decoration of dwelling unit***.

The practical experience of high-rise housing developments analysed in this study indicated that, some liveability problems such as the shortage of internal public service facilities including convenient stores, restaurants and shops, and the deficiency of activity places for the elderly and children, stemmed from the lack of understanding on the actual usage conditions of high-rise residential environments. As Herbert Gans (Gans 1968) suggested, 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 actual built environment and the users' needs, and even contradiction between the good intentions of professionals and the bad outcomes. Therefore, ***a great***

deal of empirical study on the liveability of high-rise housing estates should be carried out in order to provide the basis for the improvement on existing high-rise housing estates and the development of future high-rise housing estates.

In terms of the planning and design of future high-rise housing estates, recommendations can be given on interventions at the four spatial levels.

At the level of dwelling unit, encouragement should be given to carefully laid-out designs of high-quality luxury dwelling units. As this study has identified the important contribution of the dwelling unit to the overall residential liveability, the design of dwelling units should be given more attention. Moreover, evidence from other studies have shown that high-rise housing designed to accommodate specific social groups, especially the high-income urban elite, are more likely to achieve high liveability, as these people have a better chance to be able to afford the relative higher costs of high-rise living. Further, some internal conflicts between liveability elements need to be resolved in order to minimize the negative influences. For example, there is contradiction between the need to open the windows for natural ventilation to prevent over-heat from direct exposure to sunlight and the need to close windows to minimize noise impact. Conflicting interests also exist between the requirement of safety and energy-efficiency and the general demand of high-rise dwellers for maximized views through large glazed windows.

At the level of dwelling building, encouragement should be given to developing slab or short-slab high-rise building forms as the evidence from this study has shown their relative advantage over tower high-rise buildings in achieving liveability.

At the level of housing estate, separated pedestrian and vehicle traffic system with adequate parking spaces, a mixture of different building forms, ample out-door activity spaces specially designed for children and the elderly and good community management all point to good liveability. Therefore these features are recommended to be adopted in future designs. However, upgrading of service infrastructure within gated communities may result in the gentrification of urban space and the split of social classes, which should be further explored by more in-depth research in order to determine the suitable community scale, community boundary design and social mix, so as to minimize the negative outcomes.

Finally, at the level of urban neighbourhood, the planning of large-scale high-rise housing estates should be treated with caution. Both potential physical and psycho-social impacts on surrounding urban neighbourhoods should be carefully evaluated before planning permissions are given. Comprehensive urban neighbourhood design should be incorporated into the hierarchy of urban planning system. Specially, the threshold quantity between development intensity and environmental carrying capacity should be carefully calculated and evaluated to inform urban management and urban development.

8.4 Limitations of this study

This study seeks to dissect the liveability of the existing high-rise housing estates in China, in order to identify the major liveability strengths and weaknesses, summarize the practical experiences and lessons, as well as assist in the enhancement of liveability in future developments. However, it has to be admitted that there are limitations with this research, which suggest potentials for further research.

Firstly, the empirical evidence obtained in this research is based on case studies in one city rather than based on a nation-wide study. Although Tianjin may represent a typical case for high-rise housing development in other Chinese cities, and some of the study cases chosen are planned as prototypes for later developments to follow, nevertheless, the problems found with the study cases may only be relevant in its specific context. Therefore some of the recommendations given in this research may not be applicable for the general context.

Secondly, it has been acknowledged that there are limitations with the evaluation of liveability performance based on user-survey, as the subjective evaluation by users may not represent the true performance of the residential environment. The combination of subjective evaluation and objective evaluation can provide a more comprehensive and accurate assessment to residential environment quality. However, as the definition of liveability indicated, liveability ***per se*** is a user-centred environment evaluation based on the users' actual experience of the local environment. The limitation can be improved by more study cases and higher sampling rate.

Thirdly, the inherent limitation of the comprehensive liveability evaluation model that focuses on a series of elements may be that it lacks the inquiry into certain elements. This is probably the case with this research. This study was based on the professional perspective of housing planning and design, and adopted a hierarchical liveability evaluation model consisting of overall residential environment, four spatial levels and 58 liveability elements. Due to the limited scope and time-scale of a PhD research, this study has touched on a series of issues associated with development of high-rise housing estates in China, yet it may overlook some liveability issues, and lack depth in its discussions on the chosen issue.

8.5 Future works

High-rise housing estate is a global phenomenon. However, the outcomes are different in various contexts. In China, high-rise housing estates in the North and the South are significantly different due to the difference in climates. Moreover, in many Chinese cities, high-rise housing estates are extending from the city centre to the edge of city, even peri-urban areas. Except commercial high-rise housing estates, a great number of affordable housing estates are being developed and constructed. Given the scale and speed at which high-rise housing estates are being developed, a broader-scale study that covers a wide region and a variety of geographical locations and housing types needs to be carried out to have a more comprehensive understanding of high-rise housing estates in China as a whole.

High-rise housing estate is a very new housing form in China, and many liveability issues may not be yet apparent. Meanwhile, with further urban regeneration, the residential environment of high-rise housing estates will continue to evolve. More importantly, the types of residents could change due to housing adjustment and residential mobility. Therefore, the housing cases that have been studied in this research also require follow-up and continuous research in order to study their temporal changes in terms of achieving liveability.

Furthermore, with the large-scale urban regeneration in many Chinese cities, the traditional housing forms such as multi-level housing and courtyard house are rapidly being demolished and replaced by high-rise housing. It is necessary to carry out the study on the comparison of the liveability between high-rise housing and the other housing forms in order to provide suggestions and basis for urban redevelopment.

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Appendix 1: Liveability Evaluation Questionnaire

Dear Sir/Madam,

I am writing to invite you to participate in a research on *'Liveability of high-rise housing estate in Inner City of Tianjin, China'.* I am a PhD student in Welsh School of Architecture of Cardiff University. The overall aim of my research is to gain a better understanding of liveability of the existing high-rise housing estates from the viewpoint of the occupants who lives in, and to learn about what significant problems there are in the existing high-rise housing estates and how they influence the liveability of high-rise housing estates in the context of Tianjin, China. The results of the study will help to find methods to resolve the existing problems, and improve the guidance and criteria of planning and design of high-rise housing estates in future, in order to construct more liveable high-rise housing estates.

I hope that you are able to help me with research by completing the questionnaire. The questionnaire covers topics such as general information about you and your residential environment, evaluation of your dwelling unit, dwelling building, housing estate and your neighbourhood. The questionnaire should not take longer than 10 minutes to complete.

Your participation in this research is entirely voluntary and you can withdraw from the study at any time. If you would like to participate next step in-depth interview about your residential environment with me you can write down your contact at the end of the questionnaire or send me an email.

The information you provide will be treated confidentially and the data will be anonymised. The survey has been approved by the Research Ethics Committee of the Welsh School of Architecture (EC1208.129). If you have any questions about this survey please do not hesitate to contact me. I am happy to respond to any queries you may have.

Thank you very much in advance for your help.

ChenGuang Li
Welsh School of Architecture
Cardiff University
Bute Building, King Edward VII Avenue
Cardiff, Wales, CF10 3NB
Tel: 029 20343316
Email: Licg@cardiff.ac.uk

Liveability Evaluation Questionnaire

Section 1: General Information about Your Residential Environment

1. **What size is your flat?**
   ❑ 1-Bed-room ❑ 2-Bed-room ❑ 3-Bed-room ❑ >=4-Bed-room

2. **Which story does your flat locate?**
   ❑ 1-5 ❑ 6-9 ❑ 10-19 ❑ >=20

3. **Which type of orientation and ventilation does your flat belong to?**
   ❑ South-North with natural cross-ventilation ❑ South without natural cross-ventilation
   ❑ South-West without natural cross-ventilation ❑ West without natural cross-ventilation
   ❑ South-East without natural cross-ventilation ❑ East without natural cross-ventilation

4. **Which type of typical floor plan is your dwelling building?**
   ❑ One lift and two flats ❑ One lift and three flats
   ❑ One lift and four flats ❑ One lift and over four flats
   ❑ Two lifts and two flats ❑ Two lifts and three flats
   ❑ Two lifts and four flats ❑ Three lifts and six flats and over

5. **What form is your dwelling building?**
   ❑ Slab High-rise building ❑ Short-slab high-rise building
   ❑ Tower High-rise building

6. **Where does your dwelling building locate in your housing estate?**
   ❑ Close to the boundary of community ❑ In the middle of community

7. **What is the type of tenure of your flat?**
   ❑ Tenancy ❑ Owner - occupied

8. **How long have you lived in your flat?(Year)**
   ❑ <=1 ❑ 2-3 ❑ 4-5 ❑ 6-7 ❑ >=8

9. **Whether have you lived in high-rise housing or not before you moved to this flat?**
   ❑ Yes ❑ No

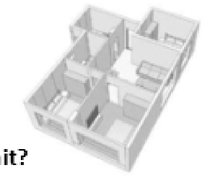
10. **What type of housing did you live in before you moved to the present house?**
    ❑ Courtyard house ❑ Low-story townhouse
    ❑ Multi-story housing ❑ High-rise housing

11. **How would you evaluate your residential environment as a whole?**

Very Bad	Fairly Bad	Neither, Nor.	Fairly Good	Very Good
1	2	3	4	5

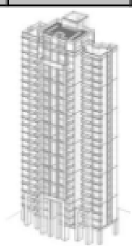
1

Section 2: Evaluation of Your Dwelling Unit



To what extent are you satisfied with the following aspects of your dwelling unit?

Factors \ Evaluation		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
1	Size of flat					
2	Layout of flat					
3	Storage					
4	Structure quality					
5	Infrastructure					
6	Indoor natural lighting					
7	Indoor natural ventilation					
8	Indoor heating in winter					
9	Indoor cooling in summer					
10	Indoor air quality					
11	Internal sound-proof					
12	Outdoor noise					
13	Private outdoor space					
14	View from windows					
15	Privacy in home					
16	Safety in home					
17	Comfort ability in home					
18	Property cost					
Overall satisfaction of your dwelling unit						



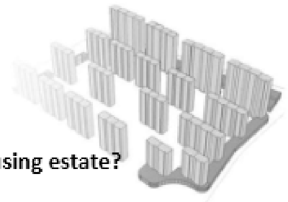
Section 3: Evaluation of Your Dwelling Building

To what extent are you satisfied with the following aspects of your dwelling building?

Factors \ Evaluation		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
1	Building form (tower or slab)					
2	Building height					
3	Building elevation					

2

4	Construction quality					
Evaluation / Factors		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
5	Quality and quantity of lifts					
6	Communal space in building					
7	Public lighting					
8	Public space ventilation					
9	Accessibility designs					
10	Household density in your dwelling building					
11	Upkeep of public facilities and spaces					
12	Collection of domestic waste					
13	Fire and earthquake safety					
14	Security in building					
15	Identity of building					
16	Relationship with neighbours					
Overall Satisfaction of Your Dwelling Building						



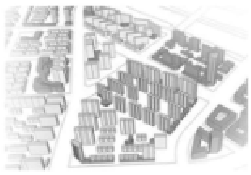
Section 4: Evaluation of Your Housing Estate

To what extent are you satisfied with the following aspects of your housing estate?

Evaluation / Factors		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
1	Green area and landscape in HHE					
2	Play area for children in HHE					
3	Activity places for the elderly in HHE					
4	Pedestrian walkways in HHE					
5	Internal motor roads					
6	Car/bike parking in HHE					
7	Public service facilities in HHE					
8	Population density in HHE					
9	Accessibility designs for the elderly and the disabled					

3

Factors \ Evaluation		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
10	Building density and spacing in HHE					
11	Outdoor environment in summer in HHE					
12	Outdoor environment in winter in HHE					
13	Wind environment in HHE					
14	Maintenance of HHE					
15	Security management of HHE					
16	Sense of community and reputation of HHE					
Overall Satisfaction of Your Housing Estate						



Section 5: Evaluation of Your Neighbourhood

To what extent are you satisfied with the following aspects of your neighbourhood?

Factors \ Evaluation		Very Dissatisfied 1	Fairly Dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly Satisfied 4	Very Satisfied 5
1	Local Public Space					
2	Local Service Facilities					
3	Noise in Neighbourhood					
4	Traffic Condition in Neighbourhood					
5	Public Transportation					
6	Environmental Tidiness					
7	Public Security Situation in Neighbourhood					
8	Sense of Belonging and Identity of Neighbourhood					
Overall Satisfaction of Your Neighbourhood						

4

About you:

1. **To what extent are you satisfied with your overall residential environment?**

Very Dissatisfied	Fairly Dissatisfied	Neither, Nor.	Fairly Satisfied	Very Satisfied
1	2	3	4	5

2. **What is your gender?**
   ❑ Male ❑ Female

3. **How old are you?**
   ❑ 18-39 ❑ 40-59 ❑ ≥60

4. **What is your highest achieved education?**
   ❑ Primary school ❑ Middle School ❑ High School ❑ University ❑ Post-graduate

5. **How much is your family income? (Yuan/Month)**
   ❑ <2000 ❑ 2000 - 5000 ❑ 5000 - 10000 ❑ 10000 - 20000 ❑ ≥20000

6. **How many people live in your flat? (Number of Person)**
   ❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ ≥5

7. **Which family members live with you? / What is your life stage?**
   ❑ Young couple without child
   ❑ Young couple with younger child
   ❑ Young couple with parents and children living together
   ❑ Mid-aged couple living alone
   ❑ Mid-aged couple with children living together
   ❑ The Elderly couple / living alone
   ❑ Mid-aged couple with parents and children living together
   ❑ The Elderly with children living together
   ❑ The others

8. **If you live in high-rise, which floor is your preference?**
   ❑ The ground floor
   ❑ The top floor
   ❑ 1st -5th floor
   ❑ 6th -10th floor
   ❑ 11th -15th floor
   ❑ 16th -20th floor
   ❑ 21st -35th floor
   ❑ >=36th floor

9. **What is your ideal housing form?**
   ❑ Single-family house with garden
   ❑ Low-story townhouse
   ❑ Multi-story apartment (<=6storeys)
   ❑ High-rise apartment (7-35storeys)
   ❑ Super-high-rise apartment (>=100 meter height)

10. **Would you be interested in participation of next step in-depth interview about your residential environment with the researcher? If 'Yes', please provide your contact detail.**
    Tel Number:____________________ **E-mail:** ____________________

This is the end of the questionnaire.

Thank you very much for your help!

5

Appendix 2: Welsh School of Architecture Ethics Approval

EC1208.129

WELSH SCHOOL OF ARCHITECTURE
ETHICS APPROVAL FORM FOR STAFF AND PHD/MPHIL PROJECTS WSA

Tick one box:	☐ STAFF ☑ PHD/MPHIL
Title of project:	Liveability of High-rise Housing Estates: an embodied multiple-case study in inner city of Tianjin, China.
Name of researcher(s):	Chenguang Li
Name of principal investigator	
Contact e-mail address:	Licg@cardiff.ac.uk
Date:	20 August, 2012

Participants		YES	NO	N/A
Does the research involve participants from any of the following groups?	• Children (under 16 years of age)		✓	
	• People with learning difficulties		✓	
	• Patients (NHS approval is required)		✓	
	• People in custody		✓	
	• People engaged in illegal activities		✓	
	• Vulnerable elderly people		✓	
	• Any other vulnerable group not listed here		✓	
• When working with children: I have read the Interim Guidance for Researchers Working with Children and Young People (http://www.cardiff.ac.uk/archi/ethics_committee.php)				✓

Consent Procedure	YES	NO	N/A
• Will you describe the research process to participants in advance, so that they are informed about what to expect?	✓		
• Will you tell participants that their participation is voluntary?	✓		
• Will you tell participants that they may withdraw from the research at any time and for any reason?	✓		
• Will you obtain valid consent from participants? (specify how consent will be obtained in Box A)[1]	✓		
• Will you give participants the option of omitting questions they do not want to answer?	✓		
• If the research is observational, will you ask participants for their consent to being observed?			✓
• If the research involves photography or other audio-visual recording, will you ask participants for their consent to being photographed / recorded and for its use/publication?			✓

Possible Harm to Participants	YES	NO	N/A
• Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		✓	
• Is there any realistic risk of any participants experience a detriment to their interests as a result of participation?		✓	

Data Protection		YES	NO	N/A
• Will any non-anonymous and/or personalised data be generated or stored?			✓	
• If the research involves non-anonymous and/or personalised data, will you:	• gain written consent from the participants			✓
	• allow the participants the option of anonymity for all or part of the information they provide			✓

Health and Safety	YES
Does the research meet the requirements of the University's Health & Safety policies? (http://www.cardiff.ac.uk/osheu/complete_risk_assessment/index.html)	✓

If any of the shaded boxes have been ticked, the supervisor must explain in Box A how the ethical issues are addressed.

The list of ethical issues on this form is not exhaustive; if you are aware of any other ethical issue you

[1] If any non-anonymous and/or personalised data be generated or stored, *written consent* is required.

should make the SREC aware of it.

Box A The Project (provide all the information listed below in a separate attachment)
1. Title of Project 2. Purpose of the project and its academic rationale 3. Brief description of methods and measurements 4. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria 5. Consent and participation information arrangements - please attached consent forms if they are to be used 6. A clear and concise statement of the ethical considerations raised by the project and how is dealt with them 7. Estimated start date and duration of project **All information must be submitted along with this form to the School Research Ethics Committee for consideration**

Researcher's declaration (tick as appropriate)	
• I consider this project to have **negligible ethical implications** (*can only be used if none of the grey areas of the checklist have been ticked*).	✓
• I consider this project research to have **some ethical implications**.	
• I consider this project to have **significant ethical implications**	

Signature Chenguang Li **Name** CHENGUANG **Date** 20 Aug. 2012
Researcher or MPhil/PhD student

Signature X [signature] **Name** PROF PHIL JONES **Date** 20/8/12.
Lead investigator or supervisor

Advice from the School Research Ethics Committee

STATEMENT OF ETHICAL APPROVAL
This project had been considered using agreed Departmental procedures and is now approved

Signature [signature] **Name** WOUTER POORTINGA **Date** 24/08/12
Chair, School Research Ethics Committee

1. Title of project:

Liveability of High-rise Housing Estates: An Embodied Multiple-case Study in Inner City of Tianjin, China.

2. Research aim

This study attempts to construct a conceptual framework that is based on the features of high-rise housing estates, and aims to diagnose the current liveability issues through surveying the existing high-rise housing estates, and to explore the relationships between the built forms and the liveability of high-rise housing estates, and to understand the dimensions and attributes of the liveability of high-rise housing estates with special reference to the inner-city of Tianjin, China.

In this study, the following research questions will be answered:

1. What are the residents' liveability evaluations of the existing high-rise housing estates? What are the main liveability issues and what are the latent reasons in the context of Tianjin, China?
2. What are the residents' 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. What are the dimensions of the liveability of high-rise housing estates? Which attributes have significant influences on the liveability of high-rise housing estates?
4. How can the planning and design of high-rise housing estates be improved to increase the liveability? How are the policies and regulations of urban housing development adjusted to guide and control the development of high-rise housing estates in order to improve the liveability in the context of Tianjin, China?

3. Research strategy: an embodied multiple-case study

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***. 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. 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.

4. 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; 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. 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 investigation 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.

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.

5. Participants

The participants are chosen at random. The participation in this research is entirely voluntary. The overall number of the participants will be approximately 200 for four study cases. The age of the participants should be over 18 years old that is the adult age standard in China. There is no criterion for gender.

6. Ethical considerations

Firstly, the design of questionnaire is based on the existing literatures, and has been checked by my supervisor and several experts during the pilot process. The questionnaire is designed as possible as compact, and the time of finishing all the questions is 6 to 10 minutes, which can make participants feel easier.

Secondly, the site survey will obtain the consent of the residents committees, Property

Management Companies and local authorities.

Thirdly, this study employ face-to-face questionnaire and interview at random. Therefore, the surveyor will introduce the information on this research to every participant, and make them understand the situation on ethical issues. Meanwhile, the cover letter of questionnaire includes the detailed explanation. Only when participant agree to answer the questionnaire, can the survey be carry out. During the process of survey, the participants can omit questions they do not want to answer and can withdraw from the study at any time.

Fourthly, the interview is based on the questionnaire, and is anonymized. There is no any question that may result in distress, discomfort and detriment of participants. Participants can withdraw from the interview at any time.

Last but not least, all the data is anonymized and will be treated confidentially.

7. Estimated start date and duration of the study

Survey Date	**Target Cases for Investigation**
4th (Sat.) & 6th (Mon) June	Case 4: BaoLong Bay
5th (Sun.) & 7th (Tues.) June	Case 1: ShengDa Garden
18th (Sat.) & 20th (Mon.) June	Case 3: FuLi Town (Phase I & II)
19rd (Sun.) & 21st (Tues.) June	Case 2: Style of Spring