THE MECHANISMS OF PUBLIC URBAN GREEN SPACE PROVISION: URBAN FRINGE CASES

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CERTIFICATE OF ORGINALITY

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Abstract

Public Urban Green Space (UGS) is an important component in sustainable development. The benefits of UGS have been widely acknowledged and studied, regarding their ecosystem services of urban environment, health, social wellbeing, property value, etc. To optimize the allocation of public UGS will help to improve urban sustainability in particular peoples' living environment and quality. Although an increasing number of research studies have been engaged in UGS planning, few of them have researched the impact of land use planning and development mechanisms on UGS provision in a city, particularly at the urban fringe where lands are transformed from non-urban to urban uses. This research aims to understand the reasons behind the differences of UGS provision in the urban-fringe development of different cities, by applying the economic theory of Mechanism Design (MD) for empirical comparative study.

Any initial study into UGS provision will raise the question: *"Why the outcomes of UGS planning are different among cities?"* Focusing on this main research question, this study attempts to explain the different allocations of UGS in urban development among cities based on the theory of MD. Related questions include what the mechanisms of UGS provision are in current urban development and planning processes, how the mechanisms work to impact UGS provision, and how we can optimize UGS provision in urban fringe development. Research methods including literature review, agent-based modelling, case studies, interviews, questionnaire, and comparative studies are used to deal with these questions. Four ongoing projects of urban fringe planning and development are selected as study cases, which are the projects of Hung Shui Kiu (HSK) in Hong Kong, Haidian North (HDN) in Beijing, Seestadt in Vienna, and Bushwick in New York City. Four land use planning maps regarding UGS provisions in the projects are the basis of agent analysis and comparative study.

The investigation has proceeded in two main phases. Firstly, the thesis provides an extensive literature review on land use planning, UGS, the role of agents in UGS provision, theory of mechanism design, and agent-based modelling. These previous studies help to identify the important components of the mechanisms (institutional, participatory and market) as well as the "Key Agents" (government, public, and market actors) in UGS provision, as well as to establish the research framework. Due to the public goods attributes of the studied UGS, local government is the principal as the provider of UGS while the public are the demanders and

users of UGS. In addition to these two Key Agents, in the context of the land market, agents with special-interest in real estate development and agents with special-interest in environmental conservation can also play their roles in UGS provision.

Secondly, agent-based analysis is conducted to interpret and compare the characteristics of different mechanisms corresponding to the four cases based on the roles, preferences and utilities of agents. This part is presented in three chapters that respectively examine the institutional mechanism and government roles, the participatory mechanism and public roles, as well as market mechanism and multiple agents' utilities. The attributes of local governments under the institutional mechanism of land planning are explored with surplus/deficit and revenue-based analysis. The roles of the public, together with environmental groups, under planning participation mechanism are examined by investigating public desire through questionnaire and evaluating the effectiveness of planning participation. With due reference to UGS provision mechanism in the context of the land market, the impact of amenity value of UGS and public willingness to pay for UGS provision are considered, while the barriers to optimizing UGS provision are identified.

According to the comparative study of the four cases, results indicate that each mechanism contains its own strengths and weaknesses. The allocation of UGS in the case of Aspern Seestadt in Vienna performs best regarding revenue and social utility, the success of which is attributed to many factors, including the public ownership of the state-owned land, high environmental awareness of public and effective participation, modest housing demand in market, and capable government. However, this case is too ideal to be implemented in other parts of the world. Taking the economic benefits of development into consideration, HSK in Hong Kong is regarded as a sustainable project to achieve integrated economic, environmental and social effects. By comparison, the issues of land availability and lack of public participation are the main constraints to the UGS provision of Bushwick in US and HDN in mainland China, respectively. Based on the results, the theoretical issues of adverse selection, moral hazard, and incentive incompatibility in UGS provision are discussed, followed by recommendations for optimizing UGS provision and improving land use sustainability in future planning.

This study represents one of the first attempts to apply the theory of MD in understanding the overall interest equilibrium for stakeholders under a system-wide context, linking empirical UGS provision cases with a theoretical basis. It contributes an integrative framework to better understand the mechanism of UGS provision by analysing the relationships regarding the

overall processes of planning, development and marketization, rather than only concentrating on one separated segment. In addition, the study contributes to the knowledge of UGS planning mechanisms in cross-city intercontinental scale, by exploring different roles and interests of agents in different cities. It is concluded that the optimization of UGS provision is a process of balancing divergent interests of Key Agents. Their interests must be related to the context of the city, not only to the status of economic development, income and ownership system, but also to social conditions such as environmental consciousness as well as political factors, such as the goal of government, participation effectiveness, etc. The findings of this study can be useful for policy makers, planners, and designers regarding how to improve the UGS provision and promote the public welfare of land use.

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Table of Contents

ABSTRACT ..... **I**

ACKNOWLEDGEMENTS ..... **IV**

TABLE OF CONTENTS ..... **V**

LIST OF TABLES ..... **X**

LIST OF FIGURES ..... **XII**

CHAPTER 1 INTRODUCTION **1**

1.1 RESEARCH BACKGROUND **1**

1.2 RESEARCH QUESTIONS **3**

1.3 RESEARCH AIM AND OBJECTIVES **3**

1.4 RESEARCH HYPOTHESES **5**

1.5 THESIS STRUCTURE **5**

CHAPTER 2 LITERATURE REVIEW **8**

2.1 SUMMARY OF CHAPTER 2 ..... **8**

2.2 LAND USE PLANNING **8**

2.2.1 Land Use Planning Policy *8*

2.2.2 Components of land use planning *9*

2.2.3 Urban fringe planning and development *11*

2.3 URBAN GREEN SPACE (UGS) **12**

2.3.1 The benefits of UGS *13*

2.3.2 The economic value of UGS *13*

2.3.3 The public desire for UGS *14*

2.3.4 Planning policies and failure in implementation *15*

2.3.5 The negative externalities of UGS *18*

2.4 ROLES OF AGENTS IN UGS PROVISION **19**

2.4.1 Government as the principal *19*

2.4.2 The Public as free-riders *21*

2.4.3 Special-interest groups for development *22*

2.4.4 Special-interest groups for environment and amenity *23*

2.5 MECHANISM DESIGN AND UGS PROVISION **24**

2.5.1 Theory of Mechanism Design (MD) *24*

2.5.2 Mechanisms of urban development and UGS provision *28*

2.5.3 Institutional mechanism and the interests of government *29*

2.5.4 Market mechanism and utilities of agents in land market *30*

2.5.5 Participatory planning mechanism and diversified public desires *31*

2.6 RESEARCH GAPS AND RESEARCH FRAMEWORK **33**

CHAPTER 3 RESEARCH METHODS **40**

3.1 TYPES OF RESEARCH METHODS 40
3.1.1 Comparative case study 40
3.1.2 Quantitative and qualitative methods 43
3.2 CASE STUDY 44
3.2.1 Selection of four cases 44
3.2.2 Document analysis 46
3.2.3 Field survey and interview 50
3.2.4 Questionnaire survey with public 51
3.3 CROSS-SECTIONAL COMPARATIVE STUDY 51
3.3.1 Agent-based modelling (ABM) 51
3.3.2 Agent-based Cellular Automation modelling (ABM-CA) 52
3.3.3 Comparative study 54
3.4 METHODS SPECIFICATION IN THESIS STRUCTURE 54
CHAPTER 4 INSTITUTIONAL MECHANISM AND THE GOVERNMENT ATTITUDE TO UGS PROVISION 56
4.1 SUMMARY OF CHAPTER 4 56
4.2 INSTITUTIONAL FACTORS AFFECTING UGS PROVISION 57
4.2.1 Institutional structure 57
4.2.2 Initial assignment of property right 57
4.2.3 Instruments for providing UGS 58
4.2.4 Institutional capacity 59
4.3 INSTITUTIONAL ARRANGEMENTS FOR LAND DEVELOPMENT 59
4.3.1 Hung Shui Kiu in HK 60
4.3.2 Haidian North in Beijing 62
4.3.3 Seestadt in Vienna 65
4.3.4 Bushwick in NYC 66
4.3.5 Comparison of the development mechanism 68
4.4 FISCAL CONCERNS AND ATTITUDE ANALYSIS 69
4.4.1 Government fiscal concerns in urban development 69
4.4.2 Principles of the agent-based model 70
4.4.3 Data collection of the selected case 73
4.4.4 Net revenue changes in the four cases 74
4.4.5 Comparison of government attitudes 76
4.5 RESULTS AND COMPARISON OF INSTITUTIONAL MECHANISMS 78
4.5.1 The effect of institutional factors 78
4.5.2 The enforcement of UGS planning standards 80
4.5.3 Approaches for improving UGS provision in institutional perspective 81
CHAPTER 5 PARTICIPATION MECHANISM AND SOCIAL UTILITY OF UGS PROVISION 83

5.1 SUMMARY OF CHAPTER 5 ..... **83**
5.2 PLANNING PARTICIPATION MECHANISMS **84**
5.2.1 Hung Shui Kiu in HK *84*
5.2.2 Haidian North in Beijing *85*
5.2.3 Seestadt in Vienna *87*
5.2.4 Bushwick in NYC *88*
5.2.5 Comparison of the four cases *90*
5.3 PUBLIC DESIRE IN URBAN DEVELOPMENT **91**
5.3.1 Questionnaire design and data collection *91*
5.3.2 Public desire in five aspects of general items *94*
5.3.3 The importance of different land use categories *96*
5.3.4 Public desire for UGS and living environment *99*
5.4 THE SOCIAL UTILITY OF THE UGS PROVISION **102**
5.4.1 Agent-based analysis of social utility *102*
5.4.2 Coverage Satisfaction Index (CSI) of the four cases *103*
5.4.3 Different preferences of public in and between cases *105*
5.4.4 Different utility of public in and between cases *113*
5.5 RESULTS AND COMPARISON OF PLANNING PARTICIPATION MECHANISMS **120**
5.5.1 The characteristics of public participation *120*
5.5.2 The effectiveness of planning participation mechanism *120*
5.5.3 The variation of social utility in and between cases *122*
5.5.4 Approaches for improving UGS provision in participation perspective *124*
CHAPTER 6 MARKET MECHANISM AND UTILITIES OF MULTIPLE AGENTS **125**
6.1 SUMMARY OF CHAPTER 6 ..... **125**
6.2 PRINCIPLES FOR DESIGNING THE MECHANISM **126**
6.2.1 Applying MD theory to UGS provision *126*
6.2.2 Indexes related to the utility of agents *126*
6.2.3 Maximizing expected public welfare *131*
6.3 THE UTILITY VALUES OF THE UGS LAYOUT AS MARKET OUTCOME **132**
6.3.1 The framework of Agent-based CA model *132*
6.3.2 Data sources and data processing *134*
6.3.3 Model simulation and results *136*
6.3.4 Model validation *138*
6.3.5 The utility of agents in four cases *139*
6.4 OPTIMIZING THE PROVISION OF UGS FOR MAXIMUM PUBLIC WELFARE **141**
6.4.1 Principles of UGS layout with maximum public welfare *141*
6.4.2 Model simulation and result *142*
6.4.3 The utility of agents in optimized patterns *144*

6.4.4 The gap between market outcome and expected welfare *146*
6.5 Comparison of Market Mechanisms and Barriers to Optimization **147**
6.5.1 The characteristics of market mechanisms *147*
6.5.2 Economic barriers in the four cases *148*
6.5.3 Non-economic barriers in the four cases *148*
6.5.4 Approaches for improving UGS provision in market perspective *149*
CHAPTER 7 SUMMARY OF RESULTS AND DISCUSSION **150**
7.1 Summary of Results **150**
7.1.1 Summary of literature review *150*
7.1.2 Summary results of comparative case study *151*
7.2 Adverse Selection in UGS Provision **155**
7.2.1 Selection of the planning guidance *155*
7.2.2 Selection of public desires and the externality *155*
7.2.3 Selection of interests among multiple agents *156*
7.2.4 Selection of heterogeneous land resource and ecosystem service *156*
7.3 Moral Hazard in UGS Provision **157**
7.3.1 Self-interests of government and indifference to UGS *157*
7.3.2 Self-interests of public and the lack of participation *158*
7.3.3 Self-interests for development and profit *158*
7.3.4 Roles of environmentalists and their self-interests *159*
7.4 Mechanism Design and Rules of Gaming **159**
7.4.1 Interests trade-off under different mechanisms *159*
7.4.2 Information transfer and interaction *160*
7.4.3 The context of institutional arrangements *160*
7.4.4 The context of economic environment *161*
7.4.5 The context of ideological environment *161*
7.4.6 Discussion of incentive compatibility *162*
7.5 Recommendations for optimizing UGS provision **162**
7.5.1 Sustainable planning strategies *163*
7.5.2 Improving public awareness of the living environment *163*
7.5.3 Improving the effectiveness of planning participation *164*
7.5.4 Collaboration for implementation and incentive compatibility *164*
7.5.5 Linking up the history and the future *165*
CHAPTER 8 CONCLUSIONS AND FUTURE RESEARCH **167**
8.1 Conclusions **167**
8.2 Limitations and areas for further study **169**
APPENDICES **171**
Appendix A: Interview questions and answers from the interviewees **171**

APPENDIX B: SAMPLE QUESTIONNAIRE FOR RESIDENT SURVEYS 180
APPENDIX C: GLOSSARY OF ACRONYMS 183
APPENDIX D: LIST OF PUBLICATIONS 184
APPENDIX E: AUTHOR BIOGRAPHY 185
REFERENCES 186

List of Tables

Table 1.1 Characteristics of UGSs and the category of UGS scoped in this research* 4

Table 2.1 Examples of main elements and related researches in land use planning strategy 10

Table 2.2 The relationship between landscape features and land or house prices 13

Table 2.3 Policies related to public UGS provision and failures in implementation 15

Table 2.4 The barriers and strategies for the implementation of Conservation Development (CD) 17

Table 3.1 Examples of diverse case study in previous researches 40

Table 3.2 Research methods applied corresponding to the research questions 43

Table 3.3 Green and open space provision standards for HK urban area 47

Table 3.4 Green and open space standards for Vienna 48

Table 3.5 The comparison of the UGS layouts in the four cases 49

Table 3.6 Basic information of the interviews 50

Table 4.1 Institutional factors affecting UGS provision (from literature review) 59

Table 4.2 The list of incomes and expenses in land development 71

Table 4.3 The values of the variables and the formulae in the model 74

Table 4.4 The value of the incomes and expenses in case of HSK (HK$/m^2) 74

Table 4.5 Comparison of the UGS supply mechanisms based on the changes in development revenue 76

Table 4.6 Relationship between financial attribute in development and government attitudes 77

Table 4.7 Comparison of government attitudes under four mechanisms 78

Table 4.8 The comparison of financial attribute and UGS outcome in the four cases 79

Table 4.9 The comparison of planning standard and UGS outcome in the four cases 81

Table 5.1 The main approaches of public participation in HSK planning 84

Table 5.2 The main approaches of public participation in Seestadt planning 87

Table 5.3 The main approaches of public participation in Open Space planning 89

Table 5.4 The comparison of participation methods of the four cases 90

Table 5.5 Related information of questionnaire survey 93

Table 5.6 The result of One-Sample T-Test in the five aspects of demanding items (N=609) 94

Table 5.7 The importance of different land uses in the four cases based on the mean ranking value 96

Table 5.8 Mean difference of the importance rank in four cases (I-J) 97

Table 5.9 The relative importance of the three top-ranked land uses in four cases 98

Table 5.10 Mean difference of the UGS Percentage in four cases (I-J) 100

Table 5.11 Mean difference of the WTP in four cases (I-J) 101

Table 5.12 The comparison of the public views of UGS Percentage in four cases 102

Table 5.13 Establishment of the formulae for calculating CSI of the four cases 104

Table 5.14 The values of population variables and UGS preference related variables 105

Table 5.15 The result of parallel lines test of ordinal regression model (UGS percentage) 107

Table 5.16 The result of ordinal regression of HSK case (UGS Percentage as dependent variable) 108

Table 5.17 The result of ordinal regression of HDN case (UGS percentage as dependent variable) 110

Table 5.18 The result of ANOVA in Seestadt case (UGS Percentage as factor) 111

Table 5.19 The result of ANOVA in Bushwick case (UGS Percentage as factor) 112

Table 5.20 The result of ANOVA and LSD regarding public selected UGS quantity in Bushwick (by Age) 113

Table 5.21 The result of ordinal regression of the four cases (Willingness to pay as dependent variable) 114

Table 5.22 The result of ordinal regression of HSK case (WTP as dependent variable) 115

Table 5.23 The result of ordinal regression of HDN case (WTP as dependent variable) 117

Table 5.24 The result of ANOVA in Seestadt case (WTP as factor) 118

Table 5.25 The result of ordinal regression of Bushwick case (WTP as dependent variable) ... 119

Table 5.26 The comparison of participation process and UGS outcome in the four cases 121

Table 5.27 The comparison of statistically significant impact factors affecting UGS Percentage and WTP in the four cases 122

Table 6.1 Variables related to the land use patterns and the utility of agents 127

Table 6.2 The relationships between the preference and the utility of agents associated with indexes[#] 128

Table 6.3 The basic information of the vector data of the four cases 134

Table 6.4 The basic information of the raster and ASCII data of the four cases 135

Table 6.5 The result of the indexes regarding the planned UGS layouts in the four cases (market condition) 137

Table 6.6 The comparison of the final value of spatial indexes from ArcGIS and Netlogo (Case: HSK) 139

Table 6.7 The result of the indexes regarding the optimized UGS layouts in the four cases (public welfare maximization) 144

Table 6.8 Change of the index value from the market condition to the optimized pattern (C–B) 146

Table 6.9 The indexes associated with the loss of utility in the optimization of UGS provision 147

List of Figures

Figure 1.1 Research Structure of the Thesis 6
Figure 2.1 The graph generated within HistCite showing the 40 highest LCS nodes 9
Figure 2.3 Identified four key agents in this study 24
Figure 2.4 Conceptual model for real estate development and the hierarchical mechanisms of urban development 28
Figure 2.5 The theoretical framework for applying MD theory to UGS provision 36
Figure 2.6 The research framework for analysing the mechanism of UGS provision 38
Figure 3.1 The criteria of case selection in this study 42
Figure 3.2 The UGS planning layouts of the selected four cases 46
Figure 3.3 Examples of neighbourhood in CA models 53
Figure 3.4 Research methods specification in thesis structure (in red characters) 55
Figure 4.1 The relationship between institutional mechanism and UGS provision 56
Figure 4.2 The location (a), scale (b), and current land use situation (c) of HSK 61
Figure 4.3 Land development process of HSK, HK 62
Figure 4.4 The location (a), scale (b) and current land use situation (c) of HDN 63
Figure 4.5 The Blocks in HDN plan (left) and the selected 4-2 & 4-3 Blocks (right) 64
Figure 4.6 The land development process of HDN, Beijing 65
Figure 4.7 The location (a), scale (b) and current land use situation (c) of Seestadt in Vienna ... 66
Figure 4.8 Land development mechanism of Seestadt, Vienna 66
Figure 4.9 The location (a), scale (b) and current land use situation (c) of Bushwick 67
Figure 4.10 Suburban land development dynamics of Bushwick 68
Figure 4.11 Processes and the roles of agents in land use of the four cases 69
Figure 4.12 Comparison of wealth gained by government under the four development mechanisms 75
Figure 4.13 Comparison of the relationship between R_g and the Revenue of government 76
Figure 5.1 The diagram of the relationship between planning participation mechanism and UGS provision 83
Figure 5.2 Planning process and participation mechanism of HSK, HK 84
Figure 5.3 Photo of public forum of HSK development study (taken by the author in Aug. 2015) 85
Figure 5.4 Planning participation mechanism of HDN, Beijing 86
Figure 5.5 The screenshot of publicity information in the website of the planning commission . 87
Figure 5.6 Planning participation mechanism of Seestadt, Vienna 87
Figure 5.7 Planning participation mechanism of Bushwick, NYC 89
Figure 5.8 Photos of public participation in the Bushwick plan 90
Figure 5.9 Methods and level of involvement 91

Figure 5.10 Gender distribution (left pie) and age distribution (right pie) of the respondents* .. 94
Figure 5.11 The boxplot of the importance score of 36 items 95
Figure 5.12 The overall importance rank of different land uses 96
Figure 5.13 The importance rank of different land uses in each case 97
Figure 5.14 The mean importance value of items associated with UGS 99
Figure 5.15 The result of satisfaction to current UGS Percentage (left) and planned UGS Percentage (right) 100
Figure 5.16 The result of the reasonable percentage of green space in four cases 100
Figure 5.17 The result of the willingness to pay for amenity value in four cases 101
Figure 5.18 The analysis of public desire for R_g based on questionnaire survey of the four cases 104
Figure 5.19 The relationship between CSI and R_g in the four cases 105
Figure 5.20 The flowchart of analysis regarding the relationships between variables and UGS percentage 107
Figure 6.1 The diagram of the relationships between market mechanism and UGS provision 125
Figure 6.2 Spatial illustration of green space, catchment area, catchment radius (r), and distance ($d_{i,j}$) 127
Figure 6.3 The conceptual framework of the agent-based cellular landscape model (public landownership) 133
Figure 6.4 The conceptual framework of the agent-based cellular landscape model (private landownership) 134
Figure 6.5 the interfaces of the initial layout (a) and the final layout (b) of the model 136
Figure 6.6 The result of the dynamic plots of the indexes in the simulation of the four cases ... 137
Figure 6.7 The changes of indexes related to the utility of government (B-A) 140
Figure 6.8 The changes of indexes related to the utility of private land owners 140
Figure 6.9 The changes of indexes related to the utility of developer and public (B-A) 141
Figure 6.10 The procedure of the simulation to form the optimized UGS layout 142
Figure 6.11 The result of the optimized UGS patterns (left column) and the plots of indexes (right column) in the four cases 144
Figure 6.12 The changes of indexes related to the utility of government (C-A) 145
Figure 6.13 The changes of indexes related to the utility of private land owner (C-A) 145
Figure 6.14 The changes of indexes related to the utility of developer and public (C-A) 146
Figure 7.1 Hierarchical mechanisms of UGS provision and systemic factors 154

CHAPTER 1 INTRODUCTION

1.1 Research Background

Ever since the precedent-setting utopian concept of the Garden City (Howard, 1965) was introduced, the importance of green spaces in urban development has been continuously debated and emphasized. As a result, a set of environmentally-friendly planning principles and policies have been advocated and established to preserve more natural land or provide more urban green space worldwide, particularly in conjunction with the trend of planning sustainable cities. The concept of Urban Green Space (UGS) is favoured as it provides both environmental benefits such as climate mitigation, noise reduction, air purification, and promotion of biodiversity (Kabisch et al., 2015), as well as social benefits, such as positive emotions (Zhang & Lin, 2011), social contact (Maas et al., 2009), and improved health for some users (Lee & Maheswaran, 2011). Economically, the positive relationship between property price and UGS has been supported by many cases and studies (Hui et al., 2012; Voicu & Been, 2008). In worldwide countries and cities, policies for green space conservation have formed a strong system where protection and planning control are the primary considerations. However, although the benefits of urban green spaces are generally well understood by planners around the world and the adaptive solutions could be effective, acceptable and feasible, the biggest challenge is implementation (Kabisch et al., 2015; Williams et al., 2013). It is manifested that to achieve the optimal level of public UGS, understanding of the underlying mechanism of provision is a prerequisite. Therefore, how to integrate theories and practices to achieve an optimal system-wide solution/mechanism, despite the self-interest of individual agents in UGS provision, is of vital importance.

One of the most relevant theories for optimizing resource allocation is Mechanism Design (MD), which concerns the problem faced by a principal or planner in designing a “mechanism” by which a set of agents with productive capacities or consumption needs and preferences will interact with one another to produce resource allocation outcomes (Mookherjee, 2008). Although the MD theory prevailed in economic science, its application in allocating land resources remains scant except for few studies. Burton (1996) explored the possibility of MD for the allocation of environmental resources in dealing with the competing interests of the "forest industry" and "environmentalists" for three possible land uses to determine the preferences of each group and thereby to determine the socially optimal allocation with a

modified version of the Groves mechanism (Burton, 1996). To alleviate the output slippage of EU set-aside policy, incentive-compatible mechanisms are suggested as establishing differential reference yields on the basis of land quality, expanding the scope of set-aside monitoring, and justifying the modification costs (Fraser, 2001). However, the previous studies mainly focus on the incentives applied to a bargaining strategy or the analysis of a specific policy and have seldomly concerned the complex contexts of and the influences of different contexts such as environment, markets, agencies, and processes on UGS provision.

The design of the mechanism should concern both an individual perspective and institutional perspective, while the latter is important in comparative study since the variation of agents' interests is the outcome of different conditions. Taking the effect of the political system as an example, in multi-party countries, the preference of decision makers is to satisfy the wishes of the voter who guarantees a majority on the basis of median voter theorem, in order to be re-elected (Choumert & Salanie, 2008). However, in one-party countries, the behaviour of local government is motivated by the up-down official promoting system. Local government in China has been actively pursuing land development by as a means of revenue generation to finance local economic growth, and consequently as the pace of urbanization and economic development increases, the goal of maximizing land lease revenue may even cause the loss of public green spaces (Chen & Hu, 2015; Lin & Yi, 2011). Another influential factor associated with government power in allocating land resources is the ownership system. In addition to the importance of delimiting property rights to protect public land supported by Coase's Theorem, it has also been observed that in public good settings the initial property right assignments tend to determine the final allocation entirely (Mookherjee, 2008).

In the context decision making, the government's structure is determined by several factors: instrumental considerations; historical development; as well as by ideological views, with respect to the desired regimes and the distribution of social power (Rausser et al., 2011). When the city context changes, can the strategies for green city development be transferred from one city to another? If yes, then under what conditions? How can we promote sustainable development by learning from the successful experiences in green cities and applying the strategies to cities confronting urban environment issues? Regarding the neglectable effects of the context on agents' interests and preferences in Urban Green Space (UGS), there is a knowledge gap in how to design an incentive-compatible mechanism to maximize system-wide utility of UGS provision under different city contexts. This will be the focus in this study.

1.2 Research Questions

In the field of UGS research, how to optimize its allocation has been long debated. To deal with this debate, it is important to determine the mechanism behind UGS provision, since the eventual landscape is the output of a specific mechanism. Therefore, the main question is "**Why the UGS layouts are different among cities?"** To answer such a question, there are a few more specific issues that need to be addressed. One needs to find the relationship between the attributes of the mechanism (input) and the layout (output). Between the input and the output, is the operation of the mechanism, in which the agents play their roles to run the mechanism and interact with each other to make decisions based on their interests or utility concerns. Mechanism, agent (people), and UGS layout are the three most important components to be studied. In the whole thesis, the hierarchy of inter-connected research questions is identified as follows:

What is the mechanism of UGS provision in development?

- What factors are influential to the attributes of a mechanism?
- What are the current processes and rules of UGS provision in the selected city cases, and how are the mechanisms differentiated?
- Do the attributes of a mechanism relate to the performance of the UGS layouts? If yes, how are they related?

Who makes decisions and influences the planning outcome?

- Who are the agents (government, public, developer, etc.) running the mechanism?
- What are their preferences and how do they play their roles in the planning and development process?
- What is the relationship between their utilities in UGS provision and the mechanisms?

How to design the mechanism to balance the interests of different agents for greener layouts?

- What are the difficulties/barriers (e.g. the loss of utility of particular agents) in optimizing UGS provision?
- For each case/mechanism, what are the advantages and the encountered restrictions?
- What are the approaches for overcoming the restrictions?

1.3 Research Aim and Objectives

In dealing with the research questions, this research aims to understand the reasons behind the differences of UGS provision in the urban-fringe development of different cities, by applying the theory of Mechanism Design for empirical comparative study. Specific objectives are listed below:

a) To understand the UGS provision mechanisms which are used in the current urban development processes of the 4 different cities, by identifying the involved agents and scrutinizing the processes;
b) To analyse the impacts of the mechanism in the 4 cities on agents' roles and interests, by focusing on the three components, i.e. institutional, participatory and market mechanisms;
c) To suggest the approaches for optimizing UGS provision, based on the understanding of advantages and restrictions of the three components in each of the 4 cities' mechanisms; and
d) To appraise the hurdles/limitation in implementing optimized UGS provision mechanisms.

Since UGS contains different kinds of green areas and could not be wholly demonstrated, the research scope is confined to partially excludable and congestible UGS, namely local public goods. They are more relevant to peoples' daily life, as well as outdoor activities, and very important to the urban environment, including urban parks, gardens, squares, urban forests, sports fields, lakesides, riversides, etc. The characteristics of UGSs and the categories of UGS are scoped in this research.

Table 1.1 Characteristics of UGSs and the category of UGS scoped in this research*

	Non-rival	Congestible/Rival
Non-excludable	***Pure Public Goods:*** Landscape offered by UGSs, fallow lands, biodiversity offered by UGSs, etc.	***Open Access UGSs (Common Resources):*** Street trees, green traffic circles, tree alleys, etc.
Partially excludable	***Local Public Goods (Common Resources):*** Cemeteries, industry/commerce grounds, etc.	***Local Public Goods (Common Resources):*** Parks, gardens, squares, urban forests, sports fields, lakesides, riversides, etc.
Excludable	***Club Goods:*** House gardens, community gardens, etc.	***Private Goods:*** Golf courses, parks with entrance fees, domestic gardens, green roofs, green walls, urban teaching farms, etc.

**Note: The categories of UGS studied in this research are highlighted by the red rectangle.*

Sources: Adapted from Barchetta and Chiodelli (2016); Choumert and Salanie (2008).

1.4 Research Hypotheses

Referring to the key research question: "**Why the outcomes of UGS planning are different among cities?**", the relationship between the mechanism and agents' interests as well as the performance of UGS provision is the key issue to be explored. Based on the theories of utility, mechanism design and incentive compatibility, the basic hypothesis of this thesis is stated as:- ***The performance of UGS planning outcome is related to the mechanism of UGS provision, and the mechanism that better meets public needs at less sacrifice of utilities of other agents facilitates better UGS layout.*** According to these three components of mechanism, three propositions are proposed accordingly.

> ***Proposition 1:*** *The institutional mechanism with less sacrifice of governments' self-interests in UGS provision is more beneficial to the outcome.*
>
> ***Proposition 2:*** *The planning mechanism with more public participation helps to meet public need, positively impacts on the outcome.*
>
> ***Proposition 3:*** *The market mechanism that values UGS in urban development helps reduce the sacrifice in utilities of market agents and facilitated to better outcome.*

1.5 Thesis Structure

The thesis is organized into chapters. Figure 1.1 shows the thesis structure, followed by the brief descriptions of each chapter.

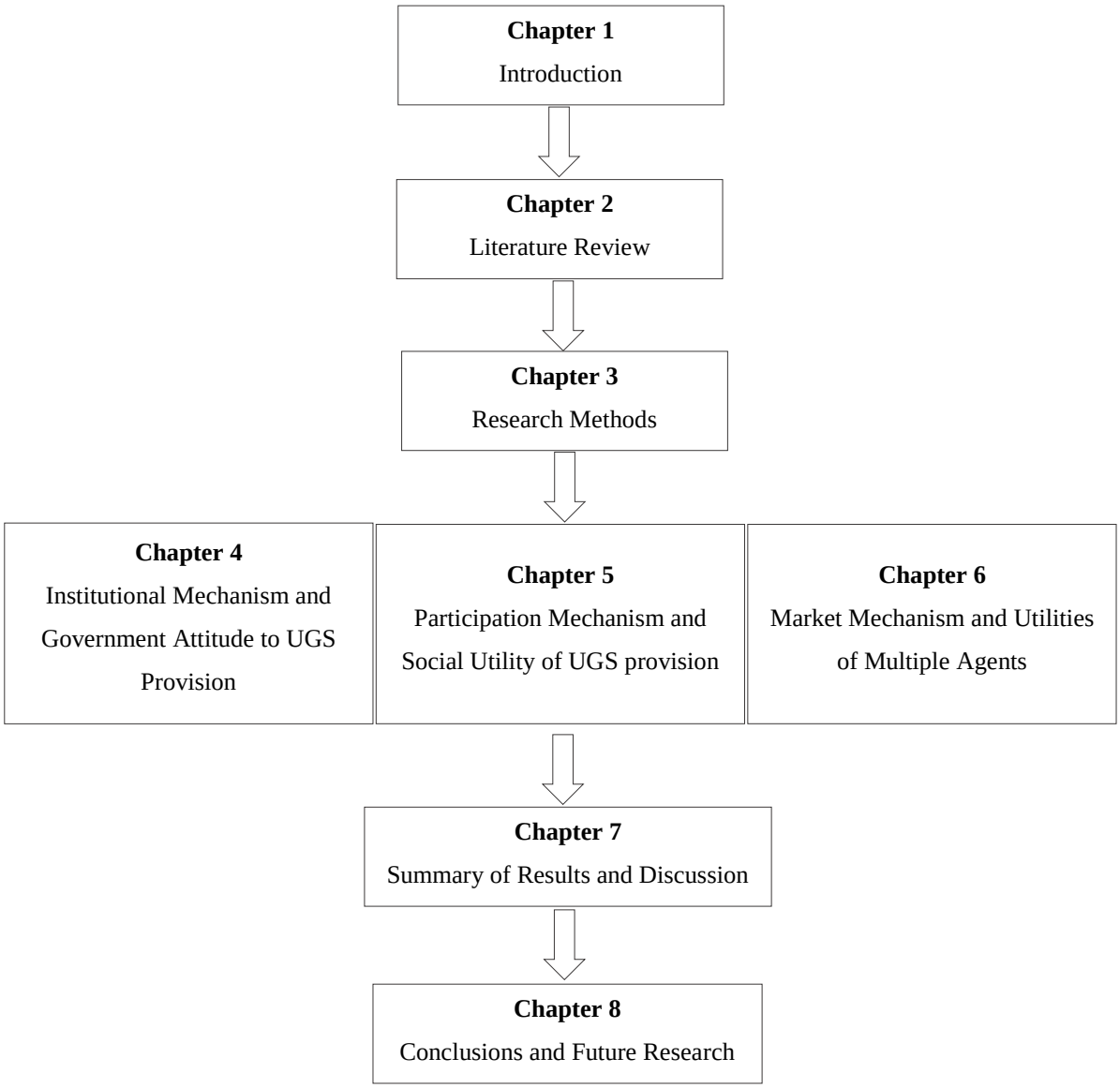


Figure 1.1 Research Structure of the Thesis

Chapter 1 introduces the research background, research questions, research aim and objectives, research hypothesis, and research methods. The structure of the thesis is also illustrated through both a figure and textual explanation.

Chapter 2 reviews past studies related to theories, methods and empirical researches of UGS and mechanism design. Four sections of land use planning, UGS, roles of agent, and mechanism design and UGS provision are included. Contributions and limitations of existing studies are discussed, following which the research gaps to be filled in this study are identified.

Chapter 3 describes the methods applied in this research, including case study and comparative study. Field survey, documentation, interview and questionnaire investigation are used for cases study, while agent-based analysis and agent-based cellular automation model are used for case comparison.

Chapter 4 analyses the relationship between the land development mechanism which is determined by institutional arrangement, and (the principal) attitudes of governments towards UGS provision based on their fiscal concerns.

Chapter 5 explores the relationship between the planning participation mechanism and social utility. The processes of participation are objectively described, while the outcomes are evaluated based on how public aspirations for UGS in terms of quantity and accessibility are satisfied.

Chapter 6 explains the relationship between the market mechanism of land use and the utilities of multiple market actors. Taking the amenity value of UGS into account, quantitative indexes are used to represent the utilities of different agents. By comparing the utilities in existing and optimized planning outcomes, barriers to optimizing UGS provision are identified.

Chapter 7 summarises the main findings and results, followed by discussion about the issues in MD. Based on the contents in former chapters, the adverse selection problem, moral hazard problem, incentives compatibility and condition of MD, as well as recommendations for UGS provision are demonstrated.

Chapter 8 provides a summary and conclusions, through which the propositions proposed in Chapter 1 are explained. The contributions to knowledge, limitations of the study and recommendations for future research are presented.

CHAPTER 2 LITERATURE REVIEW

2.1 Summary of Chapter 2

This Chapter has reviewed the available literature regarding UGS provision and its mechanism, aiming to identify the state of current knowledge that currently exists and the knowledge gap that this study aims to fill. The review started within the broad context of land-use planning to demonstrate what the current status that UGS provision generally holds within planning and development (Section 2.2), and then the focus narrowed down to research studies about UGS, regarding its benefit, economic value, popularity in public, policy failure and externality (Section 2.3). Targeting at explaining the reasons for the failure in policy implementation, agents and mechanisms associated with UGS provision need to be more deeply understood. Hence, studies regarding the role of agents in UGS provision are reviewed (Section 2.4), and the mechanisms are stated based on existing literature in three levels of institutional, participatory and marketing, together with some elaborations of the theory of Mechanism Design (Section 2.5). This research aims at filling the research gap of the cross-city comparative study and an understanding of the mechanisms of UGS provision worldwide, focusing upon which the research framework is established at the end of this Chapter.

2.2 Land use planning

2.2.1 Land Use Planning Policy

Through the Web of Science, by searching using the keywords of “land use planning policy”, 3219 items from the year 2000 were found in January 2015, including over 3000 articles, some proceedings papers, reviews, editorial materials, etc. About one third of the items came from the USA, followed by those from the UK, China, Australia, Netherlands and Canada. As for the sources, journals of “Land Use Policy” and “Landscape and Urban Planning” showed the largest quantity of the items through the results.

To analyze the focused topics in this research area, records of the searched items were imported into HistCite. Using the “graph maker” tool in this software, the top 40 records with highest Local Citation Score (LCS) were identified, which means they were cited most by other imported records and were chosen to show their relationships.

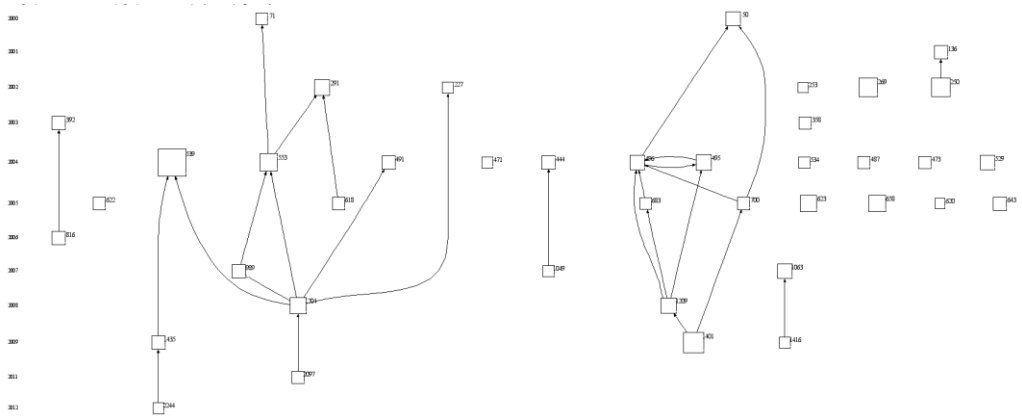


Figure 2.1 The graph generated within HistCite showing the 40 highest LCS nodes

As shown in Figure 2.1, each node (represented by a square) represents an article, and each line means a citation connection. Among the top 40 records, focused topics were highlighted by two groups, one was summarized as growth management and the other was ecological conservations. Both began with the articles in the same year (Dale et al., 2000; Kline, 2000), while others were distributed separately with few links. However, there are still some articles which are not linked with the two groups, concerned the topics of growth management (Ye et al., 2005) or ecological conservations (Brody & Highfield, 2005; Bulkeley & Betsill, 2005; He et al., 2000; Verburg & Veldkamp, 2004) as well. Other separated nodes presented researches on technological analysis such as land modelling and scenario simulation (Jantz et al., 2004; Johnston & De La Barra, 2000; Lapola et al., 2009; Lin et al., 2007; Tong & Chen, 2002), land use planning related social issues (Bohnet & Smith, 2007; Paquette & Domon, 2003; Quetier et al., 2010), and other specific topics.

2.2.2 Components of land use planning

Many research studies in land use planning focused on the specific problem, as one component of the planning strategy. The planning components were further classified into five aspects, which are housing, transportation, water, landscape and layout pattern. Housing, regarding housing supply, housing area, housing types, affordability and other factors, is an important approach to living and environmental considerations. Transportation is a spatial policy tool in shaping urban form. Water, with the process of supply, use, collection and treatment, is bound inextricably with residential land development. Landscape has attracted greater attention and the public needs of open space have increased not only in dimension but also in landscape functions. Layout patterns of the metropolitan areas were varied in housing location, urban density, spatial structure, and other morphologic factors of the city. Examples of the research topic were listed in Table 2.1.

Table 2.1 Examples of main elements and related researches in land use planning strategy

Aspect	Aim\Result	Strategy/Policy Design	Reference
House	meets housing need of low-income households	specify goals of housing types and density targets	(Aurand, 2010)
	preserve open space with upper class sprawl	increasing the minimum lot area of rural housing	(Rudel et al., 2011)
Transportation	evaluate the differences in land use and transportation from different policies	use integrated transportation and land use models to explore several options	(Conder et al., 2002)
	reduce urban sprawl	increase travel costs and cluster infrastructure and public transportation	(De Vos & Witlox, 2013)
	reduce environmental impacts and household costs in Los Angeles	Transit-oriented smart growth \mixed-use infill development	(Nahlik & Chester, 2014)
		Trade-off among lifestyles, groundwater sustainability, pace of growth, and risk of shortage	(Gober et al., 2011)
Water	reduce flood exposure due to land use changes	provide sufficient denoted safer areas for development	(Cammerer et al., 2013)
	assess the impact of sewer expansion on residential development patterns	adjust the sewer expansion time to influence the location of residential development	(Hanley & Hopkins, 2007)
	address the confliction between water resource supply and demand	restrict the water use and land use of consumers	(Giacomoni et al., 2013)
		Trade-off among lifestyles, groundwater sustainability, pace of growth, and risk of shortage	(Gober et al., 2011)
Landscape	identify relations between city and agriculture in Montpellier	pay attention to public awareness of agriculture protection and the emerged new farming systems	(Perrin et al., 2013)

	meet open space needs	protect agricultural land and reveal the benefits of other open space	(Crick & Prokopy, 2009)
	meet open space needs in England	garden sites might be crucial in meeting targets	(Sayce et al., 2012)
	meet green needs in Melbourne, Australia	retain a variety of landscape types on the urban fringe and promote between landscape functions	(Ives & Kendal, 2013)
	meet Flanders' green needs	put domestic gardens on the agenda	(Dewaelheyns et al., 2014)
Layout pattern	housing location, urban density and trip making	construct polynucleated pattern, intervene regeneration strategies and integrate current plans	(Breda-Vasquez & Ribeiro-Ramos, 2002)
	deal with accelerating urban sprawl in depopulating	Implement higher building densities, activate inner city quarters and apply effective planning instruments	(Hoymann, 2011)

In summary, growth management and ecological conservations are two hot-spots in the research area of land use planning policy, both of the topics being related to green space. In land use planning, landscape is one of the indispensable components, not only as a separated planning system but interacted with other components in urban development and living environment. Land use planning is the guidance covering a range of detailed and functional development control issues and illustrating how much UGS to build and where to locate it (Randolph, 2012; Ratcliffe, 2009). Thus, the question of how to design urban landscape through the provision of green space is of vital importance in land use planning, as well as the coordination between humans and nature.

2.2.3 Urban fringe planning and development

Urban fringe, or rural-urban fringe is difficult to define, since there are no definite boundaries administratively, either regionally or locally but rather an abstraction of reality characterised by a boundary which is 'fuzzy' and permeable (Aggrey, 2013; Scott et al., 2013). The earlier version of its definition is as follows.

> *"The rural-urban fringe is the zone of transition in land use, social and demographic characteristics, lying between (a) the continuously built-up urban and suburban areas of*

the central city, and (b) the rural hinterland, characterized by the almost complete absence of nonfarm dwellings, occupations and land use, and of urban and rural social orientation" (Pryor, 1968).

The scope of urban fringe in rural-urban context can be illustrated in the Figure below.

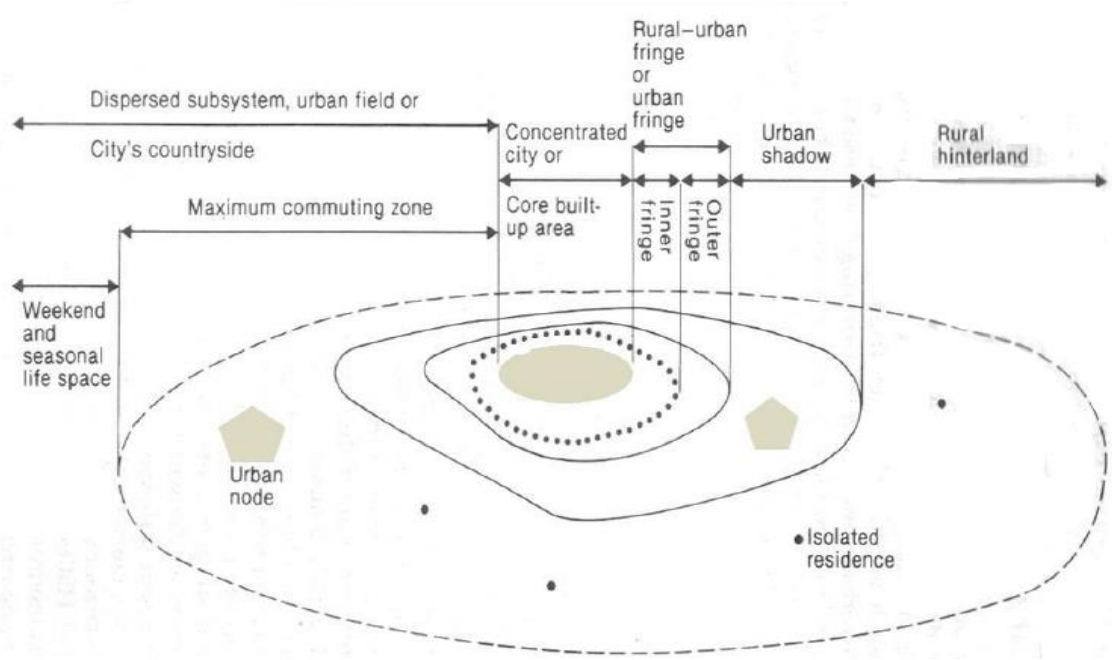


Figure. The scope of urban fringe in rural-urban context

Source: Adopted from Aggrey (2013).

Even though both the spatial-oriented theories and economic theories are considered to define urban fringe, there is no a single dominant theory or paradigm of land-use change that can also offer a cogent explanation of rural-urban fringe phenomena, and therefore, different literature sources are observed with the aim to derive partial insights on different aspects of a rural-urban fringe (Aggrey, 2013).

The development in urban fringe area is an important approach for land supply in growing cities. These areas are regarded as zones managed to resist against urban sprawl in many countries, represent the conflicts between the urban management system and local development resulting from political transformation (Zhao et al., 2009). However, it is hardly surprising that the urban fringe is often portrayed as a negative space reflecting the failure of planning (Scott et al., 2013). Adjacent to rural resources, the fringes show higher ecological value than built-up areas and deserve attention from environment protection and mitigating the impact of urban development on rural ecology. Consequently, the provision of UGS in urban fringe development is focused in this study.

2.3 Urban Green Space (UGS)

In this section, the benefit, economic value, public desire, the implementation issue and externalities of UGS are reviewed.

2.3.1 The benefits of UGS

UGS is beneficial to the built environment regarding climate mitigation, noise reduction, air purification, promotion of biodiversity (Kabisch et al., 2015), social benefits such as positive emotions (Zhang & Lin, 2011), social contact (Maas et al., 2009), and improved health for some users (Lee & Maheswaran, 2011). Worldwide, people express their desire for human-environment interaction such as contact with nature and with others, attractive environments, recreation, privacy, design engagement, and community identity (Kabisch et al., 2015; Matsuoka & Kaplan, 2008). Open space was although proved to be a statistically significant substitution relationship with nice weather, it is a normal good for residents (Wang et al., 2012). Regarding neighbourhood satisfaction, opportunities to visit nearby shared space and having views of nature from the home were more important, compared with density and proximity to shared nature areas (Kearney, 2006). In addition to human demand, incorporating well-designed and naturally vegetated open spaces into development projects and minimizing human disturbance could mitigate impacts to mid-large sized mammals (Goad et al., 2014).

2.3.2 The economic value of UGS

Many researchers have identified the positive effects of natural landscaping on housing prices. Examples of these landscape features include neighbourhood association-owned forest and water features, as well as public parks (Bowman et al., 2012a; Waltert & Schlapfer, 2010). Six studies using hedonic price models to explore the relationship between landscape features and house prices are briefly reviewed and listed in Table 2.2.

Table 2.2 The relationship between landscape features and land or house prices

Data Source	Finding	Reference
Survey on contingent prices for hypothetical housing locations considering different environmental amenities	Preserved open space adds 5% to housing value.	(Earnhart, 2006)
A total of 758 sets of transaction data in 2003–2004 from the developers of four well-known residential precincts	Proximity to a nearby wooded area without public access was not significant, expressing a pragmatic mindset within hedonic behaviour. A view of green spaces and proximity to bodies of water raised	(Jim & Chen, 2006)

in Haizhu district, the core area of Guangzhou	housing prices, notably contributing 7.1% and 13.2%, respectively.	
Questionnaire survey conducted with households in new residences sold in 2004, Guangzhou	For the entire urban area, water views increase prices by 8.2% and green space views increase them by 8.6%.	(Jim & Chen, 2007)
Real estate, structural and sales data from the Metro GIS Regional Parcel Dataset, Ramsey County, MN, USA	The marginal implicit price increases from increasing the percentage of a home's view composed of grassy surfaces or water by 10%, evaluated at the mean home sale price, are $5517 and $7417, respectively.	(Sander & Polasky, 2009)
A sample of houses sold over the study time frame in El Paso County, Colorado	A 1% decrease in the mean distance to the Pike National Forest increases house prices by 6.4% in the homogeneous model and by 6.5% in the heterogeneous model.	(Ham et al., 2012)
A total of 1,502 single-family home sales occurring between January 2005 to December 2009 in the township of Lower Gwynedd, Pennsylvania	The open space variable is associated with a premium of as much as 5.2% on average within cluster developments relative to properties in conventional developments.	(Asabere, 2014)

According to the Table 2.2 above, preserved open space and grass or water views can raise housing prices by 5% to 13.2%, with variations occurring worldwide between cities and cases. Land designated for green and open space cannot be sold directly for built-up use to bring economic benefits from the land market. However, the related price premium does spread to nearby properties due to an improved living environment (Cho et al., 2011). Studies also show that the value attributable to UGS or the willingness to pay for UGS is a distance-decay function, and this premium value may increase as the distance to the open space decreases (Soderberg & Barton, 2014), while the scope for calculating benefits is important because aggregate benefits depend on both the per-person benefit and the number of beneficiaries (Hanley et al., 2003). Although these models represent important achievements in determining the effect of UGS on property prices, they rarely mention how the economic profits and the provision of UGS in development projects area are related and can be balanced in normal market conditions. Thus, the impact of UGS will be considered in this study.

2.3.3 The public desire for UGS

The green coverage rate, which means how much of the land is covered by greenery, or otherwise be urban grey, influences the landscape morphology as well as the availability of

nature. It is found that regardless of the style of urban design, lower levels of neighbourhood tree cover were associated with reduced frequency and duration of visits to UGS (Shanahan et al., 2017). In addition to green coverage, the availability could also be measured by accessibility or closeness to GS. As supported in many researches, the creation of accessible outdoor spaces is related to recreation and improvements in physical activity (King, Litt, Hale, Burniece, & Ross, 2015). Although the attitudes to UGS were shaped by several factors, such as age, social and economic status, ethnic origin, familiarity, place of upbringing and residence, and whether urban or rural, the overall view of the general public is one that highly values the countryside as well as parks and green spaces nearer to home (Morzillo et al., 2016; Swanwick, 2009). Although public desire for UGS is evident worldwide, natural availability was threatened by the irresistible trend of urban development, such that the overall benefits for the economy, environment and society are difficult to balance. Therefore, to better understand their relationship, it is essential to link UGS layout with economic benefits as well as the availability of UGS e.g. green coverage rate and reachable distance, which have not yet been demonstrated in any previous study.

2.3.4 Planning policies and failure in implementation

Worldwide, in counties and cities, policies for green space conservation have been formed into a strong system where protection and planning control are the primary considerations, with governmental and legislative interpretation. However, generally, the policies were not well implemented as intended in their initial designs, due to the challenges and barriers confronted in implantation stage. It is suggested in previous research that although European and USA cities for many years have been investing in green space development and restoration, green space maintenance and development remains a challenge for cities in the developing world, particularly in megacities (Kabisch et al., 2015). Related policies of UGS provision and observed failures were summarized in Table 2.3.

Table 2.3 Policies related to public UGS provision and failures in implementation

Policy/Strategy	Content	Failure	Reference
Standard approach	A certain amount of UGS is required in any development, to establish minimum accessible UGS for urban residents.	Quantitative open space standards are often not reached in worldwide cases. E.g. in Brisbane, the standard of 10m^2 UGS per capita had not been achieved for certain consolidation area.	(Byrne et al., 2010; Haaland & Van Den Bosch, 2015)

Planning/zoning scheme	The use of identified piece of land is specifically restricted by planning ordinance, such as for UGS only.	The authorized UGS zones are developed for other uses. E.g. in some Chinese cities land developers modified the zoning schemes and local governments gave in after lengthy negotiations with developers.	(Lin & Li, 2016)
Land preservation program	Acquiring/purchasing the land for UGS with permanent protection, normally using ecological principles in the ranking of properties for acquisition.	The efficiency of land preservation is insufficient. E.g. in Michigan the target for acquisition of OS is approximately 10% of the currently undeveloped parcels in the township.	(Thomas, 2003)
Green infrastructure development	Developing green infrastructure (GI) to integrate building with nature, such as providing shade and shelter in cities.	Mismatch between policy aims and the potential on the ground. E.g. in UK, a decrease in the level of GI creation is observed due to insufficient collaboration, restrictions placed upon local authorities, etc.	(Roe & Mell, 2013)
Ecosystem service approach	Improving the ecological values of urban environment by organizing ecosystem services framework in urban green planning.	Lack of ecological consideration in urban development due to increasing development pressure, financial constraints, loss of expertise, low awareness of green benefits, & insufficient communication, etc.	(Kabisch, 2015)
Conservation development	An alternative form of development in which homes are clustered and the remainder of the property is permanently protected for conservation purposes.	It is proposed in countries of USA, Australia, etc. but not being used widely and, when used, were often used to fulfill stormwater requirements rather than increasing UGS supply.	(Crick & Prokopy, 2009; Reed et al., 2014)
Localized thematic plan	A specific development plan in a country/city that partly related to UGS provision, such as the National Plan of Adaptation to Climate	Low implementation rate. E.g., few stakeholders in PNACC believe that there has been an evolution in their decision making such as to provide more vegetation of UGS or green screens and roofs	(Dhalluin & Bozonnet, 2015)

	Change (PNACC) in France		

The reasons for the failures of policy implementation could be summarized in a few aspects, including the regulation detailed, cost, market demand, information, technology, etc. For example, in the USA, the widespread adoption of conservation development has been hampered by uncertainty around economic outcomes and costs and by regulatory barriers (Allen et al., 2012; Gocmen, 2013). Likewise, in the suburban development of Beijing, China, there were doubts that the planning objectives for ecological and liveable cities could actually be put in practice (Wu & Phelps, 2011). Taking conservation development (CD) as an example, stakeholders such as officers, developers, planners, and residents are not well encouraged to implement CD, with barriers and strategies as presented in the following Table 2.4.

Table 2.4 The barriers and strategies for the implementation of Conservation Development (CD)

Aspect	Barrier	Strategy	Reference
Regulation	Land use regulations and the permitting process in general	Regulations supporting CD, incentives to CD, clarity and specificity, emphasis on potential environmental merits, coordination and consistency among professionals and agencies	(Gocmen, 2013)
		A more supportive institutional environment for alternative residential developments	(Göçmen, 2014)
	Lack of interest from elected officials	Add CS to development regulations or ordinances as a response to perceived threats to rural character	(Allen et al., 2012)
	Reluctance of planners to review sketch plans	Flexible lot sizes, varying open space requirement, shorter approval processes, density bonuses	
Cost	Greater costs for site development	Tax or density incentives	(Bowman & Thompson, 2009), (Göçmen, 2014)
	Greater costs for approval time	Change or add new fast-track or more flexible regulations	
	Misperceptions about CSD construction costs	Workshops and informal meetings e.g. save money on stormwater management	(Allen et al., 2012)

	No incentives for developers	Density bonus, flexibility in lot size requirement, or an expedited review process	
Demand	Limited consumer demand	Multiple meeting and workshops	(Allen et al., 2012)
	Acceptance of smaller lot size	Reduced setback requirement and flexibility in lot sizes	(Allen et al., 2012)
	Developers with limited concern for natural environment, awareness of CSD benefits, etc.	Education on ecological sound land development and planning practices Different kinds of regulations and guidelines for natural resource protection	(Göçmen, 2014)
Information	Information about consumer preferences to developer	Independent market studies to gather local and real-time market information for developers	(Bowman & Thompson, 2009)
Technology	Lack of technique support for decision making	Providing land of maps of potential conservation lands	(Allen et al., 2012)

2.3.5 The negative externalities of UGS

The increasing use of green strategies as primarily market-driven endeavours resulted in an unequal distribution whereby the middle class and higher income groups get benefits at the expense of less privileged residents; meanwhile, gentrification was an unexpected result of greening projects (Haase et al., 2017). Because of asymmetries in economic and political strengths between interest groups, it is challenging for planners to find a pareto-superior solution, mediating the divergence between competing interest groups and negotiating with parties to divide their mutually beneficial gains (Hawkins, 2014). These externalities could be explained as problems of adverse selection and moral hazard in MD, to be specific, the unobservable private information of excluded agents and the uncontrollable decision domains of included agents. To optimize the allocation of UGS and internalize the negative externalities, empirical approaches, involving objective facts, understanding agents' interests, measuring the trade-offs of multiple agents, participation, and coordination of multi-agents' preferences/interests, should be the main concern all through the planning process. Planners together with professional associations, are encouraged to translate a rational ecosystem approach into practical planning and management tools (Everard, 2013).

To summarize, UGS is favoured for its environment and social benefits, while its economic value indicates market recognition of urban greenery. However, despite the widely perceived favourable values of UGS, actual green development projects appear to be less prevalent in reality than in conceptual proposals, due to the practical barriers of regulation, cost, market demand, information, technology, limited economic outcomes, etc. Additionally, social issues of inequality, displacement of local residents, etc., taken as negative externalities of UGS provision, have attracted increasing attention of researchers regarding urban sustainability. Therefore, how to guarantee the implementation of urban greening policies with more favourable UGSs and less negative externalities, is important to achieve sustainable goals in urban planning.

2.4 Roles of agents in UGS provision

In the field of economics, economic agents refer to people, and an agent is an actor and more specifically a decision maker in economic activities. In the provision of UGS, there are many people or to say agents involved in the decision-making process. They are summarised as government, public, groups with special interest of development, and groups with special interest of amenity.

2.4.1 Government as the principal

In contrast to the early study of MD theory concerning the Pareto-optimal outcomes based on prefect information of all agents, the concept of principal–agent considerably improved the practicability of MD theory, where the principal (the most important agent who can represent other agents in decision-making) relies on the imperfect information of other agents and set the rules for agents to act (Laffont, 2002). Due to the public attribute of UGS, a municipal government or bureaucrat, basically plays the role of principle since it applies dominant political power in the provision of UGS. In other words, local governments make decisions to provide UGS on behalf of the public. The standards approach, dating back to the early twentieth century, has conventionally provided certainty for UGS planning as one set of rules to establish acceptable parks and open spaces allocations in development, such as minimum provision of park e.g. 10 acres per 1000 residents in US or maximum distance to UGS e.g. half mile in UK (Byrne et al., 2010). Based on empirical AHP analysis, local government is suggested as the main actor in the management of green open space in Medan, followed by the community and college (Lubis et al., 2015). It is also showed that greater political support from municipal councillors in South Africa, will contribute to the prevalence of UGS planning, the increase of

maintenance functions, and the decrease of funding challenges (Chishaleshale et al., 2015). When viewed from an institutional perspective, professional planners who worked for government in UGS provision, can be at the centre of personal and inter-organizational networks and interactions, and have a significant influence on the outcome of planning processes (Hawkins, 2014).

The principal-agent problem, focusing on the pursuit of private interests by the principal which compromises the interests of other agents (Hotte et al., 2016), is also conspicuous in UGS provision, since failures of policy implementation were observed in many cities. International research has shown that many local authorities facing development pressure fail to implement their 'standards', and the parks standards approach has been criticized for failing to deliver high quality parks and open space (Byrne et al., 2010). Many public green spaces are lost or degraded because of private interests in construction combined with poor legal protection of green areas and the abuse of numerous legal loopholes (Haase et al., 2017; Hirt, 2012). When urban development is designed, residential development is the focus, and nature and green space development are of low importance (Jim, 2013). Albeit the national / state level changes in land use policy to promote open space preservation, lower level / local governments resisted such state intervention, and were instead guided mainly by self-interest and peers' actions when deciding whether or not to change their ordinances (Loh, 2015).

Both national and local governments play the role of promoter in environmental planning. On the one hand, governments could make actions to overcome the barriers from developers, residents and planners respectively. For example, governments could promote conservation design by encouraging participation in workshops and design charrettes for proposed developments that may alleviate concerns of landowners, and could provide incentives including density bonuses and expedited approval processes (Allen et al., 2012). They can also intervene by educating planning staff about biological diversity conservation, volunteering for planning boards, or consulting on development reviews (Reed et al., 2014). On the other hand, governments are able to fill the gap between different agents. For example, they could solicit resident input and provide information about resident demand for these designs to developers (Bowman & Thompson, 2009). This is implied from four communities that have successfully developed conservation subdivisions, through educational efforts including informal meetings, charrettes, and workshops focusing on the environmental and economic benefits of conservation subdivisions, officials' support, and devoted planning staff (Allen et al., 2012).

Planners should also be positive to spread environmental planning, for example through

encouraging developers to use innovative designs by providing flexible standards and faster approval for low-impact or conservation designs (Bowman & Thompson, 2009). In addition, planners were responsible for preserving rural character and attracting prospective residents, by innovative subdivision design and new insights (Ryan, 2006). Sustainable landscape is an important feature in subdivision, which could not only satisfy peoples' demands, but also mitigate adverse impacts on nature resources and society. In CSD, planning staff need more knowledge about biological diversity conservation (Reed et al., 2014). Examples from Australia include domestic gardens that became popular and showed sustainability potential, with their links to suburban forms, sustainable design, social processes, and environmental and ecological functions (Ghosh, 2010).

2.4.2 The Public as free-riders

According to the free rider theory in collective action, individuals are unlikely to proactively participate in planning processes. They are solely concerned with their own personal costs and benefits, and prefer to free ride unless their personal benefits exceed the costs (Pennington, 2000). However, the understanding of individuals' perceptions is essential to provide UGS, since it help evaluate which options are likely to survive the policy process and what attributes will lead to their acceptability (Duke & Lynch, 2007). Studies of peoples' perception suggested the public are aware of environment protection, desirable for their living environment, and equipped with environmental knowledge. In a study based in Nepal, most of the people agreed that the urban forests are useful for addressing the challenging urban environment (Lamichhane & Thapa, 2012), while in Pennsylvania's Highlands, it is indicated the stakeholders were very capable of identifying important conservation areas and contribution to land conservation planning processes and efforts (Luloff et al., 2011). Although acting as individual free-riders, the collective forces of the public behaviors are indispensable. The importance of green space for residents has also been investigated in economic terms in the form of residential prices for dwellings near green space. The public awareness of the important values of UGS, whether weak or strong, could either lead to the lack of green space planning in a city, or a land market with well-designed landscape views combined with higher property prices (Haaland & Van Den Bosch, 2015).

What should be noted is the differences among individuals, since their attitudes to UGS are socio-economically driven and vary according to corresponding conditions. Regional and social disparity was found internationally as research studies on UGS have been on the developed world. Even within the developed world, residents who are willing to pay to access,

preserve, and maintain UGS tend to be from above-average income groups (Kabisch et al., 2015). Experienced-based preoccupations may also influence individuals' behaviours and prevent people from going into easily accessible UGS (Hitchings, 2013). Surveys in Chicago metropolitan natural areas demonstrated that those who believed a restoration practice was being used at the site they visited and/or lived near were much more likely to support the use of that (Gobster et al., 2016).

2.4.3 Special-interest groups for development

According to Virginia School public choice theory, a special-interest issue is defined as one which generates substantial personal benefits for a relatively small number of constituents, whilst imposing a small individual cost on a large number of other voters (Pennington, 2000). Applying this to UGS planning, the divergence in policy preferences is most noticeable between pro-development forces, for example (especially) real estate developers, and slow growth advocates, often represented as environmental-interest groups (Hawkins, 2014). Groups with special-interests for development or amenity compete with other agents to maximize their own benefits, influencing the distribution pattern of urban land resources.

The development interests of real estate developers or the housebuilding industry give them relatively little incentive to encourage UGS provisions. Even controlled by land use zoning, some real-world conservation zoning schemes may be modified, occasionally, after the lengthy negotiations between the government and land developers, so that the developers could lease the land and conduct development projects (Lin & Li, 2016). Due to their attribute of profit maximization, monetary incentives such as density bonus and financial subsidy are frequently used to gain their support in UGS provision, while regulations supporting the design, economic factors, community opposition, and the knowledge about sustainable development are also important to address their concerns (Bowman & Thompson, 2009; Göçmen, 2014). Even though developers incisively avoid reducing the land supply for real estate development, at the same time they act sensitively to observe and react to the market demand. For example, if their land is next to planned UGS, they may change to rent seekers and actually support the greening project, since the amenity premise is likely to raise the value of their adjacent land.

What developers are concerned about most is to increase their profit, through either reducing the cost or increasing the benefits, which could be directly changed through the design and construction process. Based on variables of population density, area, and slope a cost function for residential subdivisions in Tucson, Arizona was established (Mondaca et al., 2015). Life-

cycle costs for roads and sewer and water lines increase as density decreases (Najafi et al., 2007), and should be counted accurately among developers. The opportunity costs of foregoing open space for residential development are high, implying the importance of valuing the conservation of traditions that are tied to the land (Lambert et al., 2011). It is found that on-site costs per lot can decrease as lot sizes increase, which lead developers to prefer larger lots (Mohamed, 2009). The impact fee, which developers must pay if they choose not to use low impact development, is influential to the behaviour of homeowners in whether to select apartment homes. The top influential factors are the annual pay rates or capital recovery factor in a time-dependent global sensitivity analysis (Lu et al., 2013). The presence of neighbourhood association-owned forest and water features as well as proximity to public parks had significant positive effects on housing prices (Bowman et al., 2012b). However, it is difficult to determine the quantitative relations between the design or construction features and the profits. The importance of uncertainty in the outcome of new designs and the effect of that uncertainty on the cost of credit are the barriers for the widespread adoption of ecological subdivision designs (Magliocca et al., 2014).

2.4.4 Special-interest groups for environment and amenity

Referring interests beyond urban development, many collaborative groups with interest of urban environment and amenity have successfully worked on parks and recreation improvements (Litt et al., 2013). The empirical study shows how contemporary environmentalists and green stakeholders produce specific discourses and representations on global eco-frontiers. E.g. the current territorial domination carried out by contemporary eco-conquerors creating possible new geopolitics (Guyot, 2011). Nevertheless, the force of an interest group in policy-making is associated with its organizing capability, differing from individual free-riders. Organised groups in meaningful negotiations lead to a political settlement, but disorganised groups can only respond to certain policies in an uncoordinated fashion, since they are unable to reach such agreements (Rausser et al., 2011).

Overall, the key agents in terms of UGS provision could be summarised in four categories (Figure 2.2), which are government as UGS supplier and the dominated principal agent, public as UGS demander yet associated with the problem of free riding, special-interest groups for development as resisting force of UGS provision, and special-interest groups for development as impetus of urban greening. Since UGS in this study is scoped as partially excludable and congestible local public goods, the analysis is confined to the local level of planning and public

domain of the UGS category. Agents such as national or state governments and those associated with the provision of private UGS are not the focus in this study.

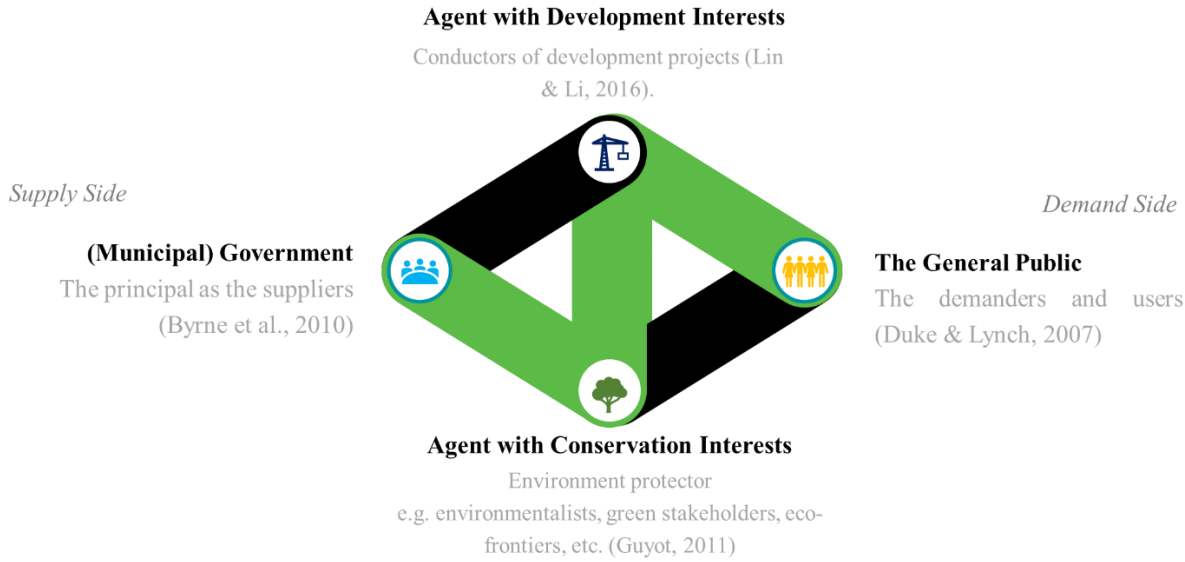


Figure 2.2 Identified four key agents in this study

2.5 Mechanism design and UGS provision

2.5.1 Theory of Mechanism Design (MD)

2.5.1.1 Brief introduction

In the early developments of mechanism theory, pioneering economists created a formal set of models intended to address classic questions concerning the economics of socialism. Hurwicz initiated the central concept of a mechanism, defined as the problem of designing a game in which agents with dispersed information communicate their private information to a central coordinator (Hurwicz, 1973). The subsequent development of the incentive branch, promoted the applications to contexts of public decision-making based on the theory of Mash implementation where agents have quasi-linear preferences (Mookherjee, 2008). Later, the most useful practical applications of MD theory have stemmed from the principal–agent or second-best version, where the principal is a social planner and his utility function is a social welfare function (Myerson, 1982). Examining the allocation rule that chooses an efficient allocation is emphasised during the development of MD theory. The Groves mechanisms are the only allocatively-efficient and strategy-proof mechanisms for agents with quasi-linear preference and general valuation functions, amongst all direct-revelation mechanisms (Vohra, 2011).

2.5.1.2 Bayesian MD for the provision of public goods

The theory of Bayesian mechanism design began with the theory of mechanisms for the provision of public goods. The provision of public goods is a central application of the theory of mechanism design (Borgers, 2015). Basic concepts for Bayesian MD are referred to the book of "Introduction to the Theory of Mechanism Design" (Borgers, 2015).

"To setup, we consider a community consisting of N agents: I= {1,2, …,N}, where N≥2. These agents have to choose whether to produce some indivisible, non-excludable public good.

Agent i's utility if the collective decision is g and if she pays a transfer t_i to the community is

$$u_i = \theta_i g - t_i \qquad (2.1)$$

Here, θ_i is a random variable that follows a continuous distribution function F_i with density f_i. We shall refer to θ_i as agent i's type, or as agent i's valuation of the public good. We denote this decision by $g \in \{0,1\}$. If the public good is produced, then g=1. If it is not produced, then g=0. t_i describe the transfer payment that agent i makes to the community for public goods. The support of θ_i is $[\underline{\theta},\overline{\theta}]$, where $0 \leq \underline{\theta} < \overline{\theta}$. We assume that $f_i(\theta_i)>0$ for all $\theta_i \in [\underline{\theta},\overline{\theta}]$."

Considering the attribute of public good, it is non-excludable for all the agents. To decide whether to provide public UGS or not is a collective decision contributed by agents. To connect the utility of agents with the decision-making of UGS provision, following assumptions are made.

"We assume that for $i, j \in I$ with $i \neq j$, the random variables θ_i and θ_j are independent. We also assume that each agent i observes θ_i, but not the other agents' types θ_j where $j \neq i$. We denote by θ the vector $\theta_1, \theta_2, \ldots, \theta_N$. The support of the random variable θ is $\Theta = [\underline{\theta},\overline{\theta}]$ N. The cumulative distribution function of θ will be denoted by F, and its density by f. The distribution F is common knowledge among the agents. We are thus considering an independent private values model of public goods. That the public good is non-excludable is reflected by the fact that the same variable g enters into each individual's utility function. The cost of producing the public good is assumed to be c>0, so that a collective decision g implies cost cg. We shall consider this society from the perspective of a benevolent mechanism designer who does not observe θ, but who knows F."

To define the utility of the outcome regarding a mechanism, the following function is formed.

"We attribute to the mechanism designer a utilitarian welfare function with equal welfare weights for all agents." Welfare is thus

$$\sum_{i=1}^{N} \theta_i g - \sum_{i=1}^{N} t_i \qquad (2.2)$$

The meanings of θ_i, *g, and* t_i are the same with those in Formula 2.1; N means the total number of agents in community.

"The mechanism designer's objective is to maximize the expected value of welfare."

When designing and operating the mechanism, each agent will send messages to the mechanism designer. However, these messages may not well show the preference of the agent. When each agent is asked to report his individual preferences, the mechanism is defined as direct revelation mechanism.

"A 'direct mechanism' consists of functions q and t_i *for* $i \in I$*, where* $q: \Theta \rightarrow \{0,1\}$ *and* $t_i: \Theta \rightarrow R$.

The function q assigns to each type vector θ *the collective decision about the public good in case that agents' types are* θ*. We shall refer to q as the "decision rule." For each agent i, the function* t_i *describes for every type vector* θ *the transfer that agent i makes when the types are* θ*."*

Under a direct mechanism, the expected utility $U_i(\theta_i)$ of the agent i conditional on her type being θ_i could be defined as

$$U_i(\theta_i) = Q_i(\theta_i) - T_i(\theta_i) \qquad (2.3)$$

Here,*"we define for each agent* $i \in I$ *functions* $Q_i: [\underline{\theta},\overline{\theta}] \rightarrow [0,1]$ *and* $T_i: [\underline{\theta},\overline{\theta}] \rightarrow R$ *where* $Q_i(\theta_i)$ *is the interim conditional probability that the public good is produced, where we condition on agent i's type being* θ_i *, and* $T_i(\theta_i)$ *is the interim conditional expected value of the transfer that agent i makes to the community, again conditioning on agent i's type being* θ_i*."*

2.5.1.3 Incentive-compatible and individually rational mechanism

Incentive-compatible and individually rational are two important terms highlight the characteristics of a mechanism. Their definitions are demonstrated as below.

"Definition: - A direct mechanism is "incentive-compatible" if truth-telling is a Bayesian Nash equilibrium; that is, if

$$\theta_i Q_i(\theta_i) - T_i(\theta_i) \geq \theta_i Q_i(\theta_i') - T_i(\theta_i') \qquad \text{for all } i \in I \text{ and } \theta_i, \theta_i' \in [\underline{\theta},\overline{\theta}] \qquad (2.4)$$

Definition: - A direct mechanism is "individually rational" if each agent, conditional on her type, is willing to participate; that is, if $U_i(\theta_i) \geq 0$ *for all* $i \in I$ *and* $\theta_i \in [\underline{\theta},\overline{\theta}]$*.*

In the timeline of the game defined by a mechanism, the phase that follows after agents have learned their types, but before all agents' types are revealed, referred to as the "interim" phase. E.g. $T_i(\theta_i)$ is the interim expected transfer of agent i if he is of type θ_i, and $U_i(\theta_i)$ as is the interim expected utility of agent i if he is of type θ_i."

Moving to UGS provision, public UGSs including parks, gardens, squares, urban forests, sports fields, lakesides, riversides, etc., are defined as local public goods which are partially excludable and congestible. Most UGSs are provided by municipalities and funded by local taxes or governmental grants (Choumert & Salanie, 2008). In UGS provision, the mechanism-design problem for the principal municipal government is to design a game or coordination mechanism for the agents which maximizes the expected social welfare, $max\ [\sum_{i=1}^{N} \theta_i g - \sum_{i=1}^{N} t_i]$, and strategies are required to design an incentive compatible mechanism for rational agents, which is a coordination system that gives the agents the incentive to do as the principal intends. Theoretically, the principal faces two constraining factors known as adverse selection and moral hazard. The former constraint means the agents may have private information which he cannot directly observe, and the latter constraint means agents may have private decision domains which he cannot directly control (Myerson, 1982).

In policy-making, the ensuring political-economic equilibrium is a solution to a bargaining game among organized groups/agents, and the cooperative solution of the bargaining game corresponds to the maximization of a certain "policy governance function" – a weighted sum of the interest groups' power over the policy-making centre (Rausser et al., 2011). The understanding of agents' interests is the basis of MD, while how different interests are weighted embrace the output of the designed mechanism. The local policy of UGS is characterized by its autonomy as well as its interdependence with the environment of the city, namely a political dimension, an economic dimension, a natural dimension and an intertemporal dimension (Choumert, 2010). Therefore, it is essential to project agents' interests into the system-wide environment, to design the incentive-compatible mechanism of UGS provision in a broader perspective.

In addition to management by government in urban planning, UGS provision in land development was also affected by other stakeholder factors. These include: developers' attributes (Maruani & Amit-Cohen, 2011); residents willingness (Bowman et al., 2012a; Jiao & Liu, 2010); as well as economic and social structures of the city. These indicate the importance of fully understanding property development processes, combining a sensitivity to

development strategies with a fine-grain treatment of the local actors' responses (Guy & Henneberry, 2000).

2.5.2 Mechanisms of urban development and UGS provision

UGS, as an important part of urban morphology, is provided in the process of urban land development (Randolph, 2012; Ratcliffe, 2009). To establish a framework for the system-wide MD, the "Conceptual model for real estate development" (Figure 2.4) provides a valuable reference to build up the mechanism levels and clarify relationships between the levels (Squires, 2015; Squires & Heurkens, 2016). The original model is established based on global real-estate development cases, to fill the research gap of worldwide development mechanisms since previous studies are limited to national scale and the institutional characteristics are illustrated in particular places and times. The mechanisms are structured in a hierarchy with five levels of Environment, Markets, Agencies, Processes, and Outcomes, from top to bottom (Squires, 2015; Squires & Heurkens, 2016). In the MD of UGS provision, the understanding of agents including their preferences, interests and utilities is the key to measure the characteristics of a mechanism. Referring to the conceptual model mentioned above, the upper levels of environment and market are the external context for agents, regarded constant in city/country scale but differential in a broader e.g. worldwide scale. The lower levels of processes and outcomes demonstrate how the land-use pattern is formed by agents through role-playing and interacting in land development. The hierarchy of urban development mechanisms could be simplified in three levels of institutional mechanism, market mechanism and agent acting mechanism. See Figure 2.4.

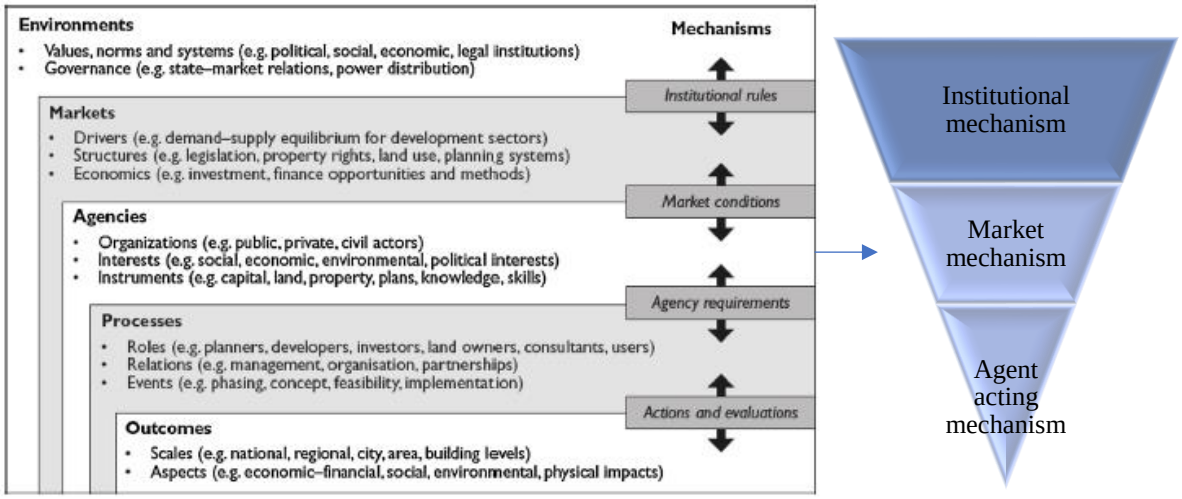


Figure 2.3 Conceptual model for real estate development and the hierarchical mechanisms of urban development

Source: the left figure is sourced from Squires (2015) and the right figure is formulated by the author.

The three levels of mechanisms formed the structure of this thesis regarding UGS provision in urban development. Based on a cross-city intercontinental scale, the top level of institutional rules is the fundamental mechanism for a specific city and essential for city comparison. Narrowing down to city scale, since variables in the upper levels could be considered constant, the outcome of land-use pattern is a result of agents' interactions in process under localized market conditions. The acting mechanism is further reflected by sequent processes, concretized as planning process, development/construction process, and administration/management. Connecting the upper, middle and lower levers, agents with their different roles in UGS provision (as illustrated in Section 2.4) are the cores in the mechanism structure to dominant localised processes, taken as an entry point to cross-city comparison.

Focusing on the research questions of this study, the research contents are condensed by integrating the roles of agents in UGS provision with the levels of development mechanisms. Three components are highlighted in this study for further analysis, which are institutional mechanism and government roles, the participatory mechanism and public roles in the planning process, as well as market mechanism and multiple agents' utilities in development. Research studies related to each component are reviewed in the following three sections.

2.5.3 Institutional mechanism and the interests of government

Institutional arrangements treats institutions as sets of rules, decision-making procedures, and programmes that define social practices, assign roles to the participants in these practices, and guide interactions among the occupants of individual roles (Young, 2002). Institutional mechanism of urban development and UGS provision implies the process of land development and UGS provision under the designated institutional arrangements, where governments are the principal agents dominating the process.

The land development process, defined as how the land is developed from getting the development right to the complement of the construction work, leads to the land-use pattern as the result of pursuing interests by agents. Due to the limited land resources in development, the land market is so competitive that the interests in other land uses, especially built-up uses such as commercial, residential, industrial, etc., will influence government attitudes in UGS planning through institutional arrangements. In America, acquisition is the most certain public policy instrument for protecting green space, but it is also the most expensive one (Bengston et al., 2004), bringing high budget pressures to the governments. Similar to the US experience, and based on analyzing the panel data across 285 Chinese prefecture cities, the results indicate

that the local governments' pursuit of maximizing land lease revenue may also cause the loss of public green spaces (Chen & Hu, 2015). In practice, planners, legislators and other leaders often choose an approach that best suits their needs. It is revealed in North Central Texas that planners and legislators there have muddled their concept of sustainability with jargon, conflated it with other causes and failed clearly to justify its pursuit (Whittemore, 2013).

The Governments' interests in land development and utilization control are varied among cities/countries regarding different contexts of land ownership, development mechanism, taxation system, etc. For example, in China, two types of public land ownership coexist, namely, collective ownership and state ownership. As regulated in the China Constitution, generally, land of urban districts belongs to the state, while rural and suburban land belongs to village collectives. It is regulated that the collectively-owned land, either farmland or built-up land, should be expropriated and converted to state ownership before it is converted to construction use, except those for township enterprise and farmers' rural housing (Wu et al., 2009). In America, people could own their land privately, and private land owners would propose to develop and sell their land without government being involved in land trading, but government would be limited to monitoring the design and construction process of the land owner or developer. For private land, it may be traded and developed for new use. However, the scales of these pieces of land as well as development projects were relatively small. In this case, to provide green space, land acquisition is an important approach so that the government agencies could restrict a property's development by purchasing preserved land trusts (Rissman et al., 2007; Stoms et al., 2009). The study on the institutional challenges of urban green space provision is worth further exploration.

2.5.4 Market mechanism and utilities of agents in land market

The market mechanism of land development is the tendency in the free market for land price to change until the market demand equals market supply at the prevailing price. Although UGS as public goods could not be priced in the land market, the related price premium does spread to nearby properties (Cho et al., 2011), through which the value of the UGS was redefined indirectly in land market. However, whether the amenity value of UGS is enough to lead to an expected outcome of UGS provision is uncertain due to the potential greater costs and less developable land when increasing UGS. Taken conservation development as an example, barriers of limited demands and great costs lead to the poor implementation of the policy. In the perspective of developers, green design and green development are very likely related to greater costs for site development, greater cost for construction, greater costs for approval time

if applying related subsidies and less buildable land for development (Allen et al., 2012; Bowman & Thompson, 2009; Göçmen, 2014) Although market incentives such as tax incentive, density bonus, and flexibility in lot size requirement (Allen et al., 2012) are followed to overcome the economic barriers, to convince the public and other stakeholders of the usefulness of green investments, it is necessary to give a correct, understandable and easily repeatable method to value the investment, e.g. by using cost-benefit as well as multiplier analyses the monetary values can be estimated (Vandermeulen et al., 2011). Under the framework of mechanism design adopted in this study, the concept of utility is then introduced.

In economics, utility is a measure of preferences over some set of goods, representing satisfaction experienced by the consumer from a good. The concept is an important underpinning of rational choice theory in economics and game theory. Utility is not only related to monetary gains but could also be represented in terms of an economic, environmental or social perspective. Local governments may connect their utilities with revenue generation and economic growth of the city or the social welfare (Chen & Hu, 2015; Lin & Yi, 2011). To most people, the high utility is related to the visual comfort of urban ecological networks, with the greening figures benefiting their psychological health (Ignatieva et al., 2011). Developers care about whether their profit could be maximized under market regulations (Maruani & Amit-Cohen, 2011). When implementing a technically excellent green plan, difficulties existing in balancing the long-term interests and relationships in protecting UGS among local landowners, political and appointed officials, and other organizations (Steelman & Hess, 2009). Therefore, compatible behaviours regarding the equilibrium of agents' utilities are essential.

2.5.5 Participatory planning mechanism and diversified public desires

Land-use planning is the guidance covering a range of detailed and functional development control issues and illustrating how much UGS to build and where to locate (Randolph, 2012; Ratcliffe, 2009). Although the plan itself will not directly distribute wealth or benefits among agents, the pattern as the outcome of planning process will guide land development which will influence the utilities of agents in land-use. Agents act in the planning process to maximize their utilities in the future land market and interact with each other to make decisions on the allocation of land resources, and the quality of decision-making in land-use planning is influenced by factors associated with public participation (Drazkiewicz et al., 2015).

The planning mechanism with public participation is a procedure of involving non-government powers to make decisions. Community participation in the design and planning of urban public

spaces can draw residents to establish a sense of attachment that may lead to the community maintaining the spaces. The quality of decisions made through community participation is strongly reliant on the nature of the process leading them to give their support (Ismail & Said, 2015). Active stakeholder participation leads to legitimate and informed future planning that accounts for society's needs (Wilker et al., 2016). Public participation will improve the quality of land-use planning. In Taipei, the Neighbourhood Park Improvement Plan encourages community involvement in the planning and design of neighbourhood parks, leading to the improvement of public recognition in facility suitability and functional benefits of the parks (Huang, 2010).

The effectiveness of planning participation varies in observed cases. It is related to the role public could play and the power they can get. The typology of citizen participation is offered, which is designed to be provocative, is arranged in a ladder pattern with each rung corresponding to the extent of citizens' power in determining the plan and/or program (Arnstein, 1969). The probability of a successful participation decreases if the relationship between objectives and techniques is ignored in the design of a participatory program (Glass, 1979), or without analyzing the context closely, identifying the purposes of the participation effort, and iteratively designing and redesigning the process (Bryson et al., 2013). Comparative study of green infrastructure investments in four Europe countries found an '*Arnstein gap'*, a significant difference between desired and actual levels of citizen participation in planning processes (Bailey et al., 2011; Wilker et al., 2016).

The public desires for UGS were reviewed in Section 2.3.3. However, since people attach different importance to natural and openness features, the public should not be viewed as agents with homogeneous interests in MD of different cities. In Detroit metropolitan area of southeast Michigan, respondents with high household incomes tended to rate natural and openness features higher, and natural and openness features were generally overshadowed by considerations for neighbourhood and housing design, schools, and access (Vogt & Marans, 2004). Similarly in Hamburg Township Michigan, although residents are pleased with the access to nearby nature as well as the social aspects of living in their neighborhoods, understanding of the open space conservation concept also varies considerably among the residents and carries little recognition of the unique features offered by such subdivisions (Austin, 2004). A strong and consistent 'pro-farmland' and 'pro-protection' attitude was highlighted, but variations emerged on why they attribute value to agricultural landscapes. For some, 'economic' values dominated, while for others, ethos of 'localism' and village lifestyle

were valued (Kaplan & Austin, 2004).

In a later study of public behaviour, researchers started to focus on residents' willingness to pay for conservation features. In Cedar Rapids, Iowa, USA, sixty-six percent of all respondents indicated willingness to pay for more embedded open space, and maximum willingness to pay was related to several factors including income, gender, desired level of open space, and concern about urban development, transactional analyses, hedonic analyses, anti-Contingent Valuation (Bowman et al., 2009). Gender, age, income, familiarity with Low Impact Development LID practices, perceptions of attractiveness of features and the perceived effect of CSD and LID features on ease of future home sales were important factors influencing residents' willingness to pay (Bowman et al., 2012b). In China, positive attitudes and strong willingness toward participation were discovered despite socioeconomic variations, fitting into a global trend of increasing civic consciousness and strengthening the theoretical base of public participation (Shan, 2012). However, few researchers have detected the impact of city context on the public interests in UGS and the cross-city differences in the effectiveness of planning participation, regarding the diversified desires of the public.

2.6 Research gaps and research framework

Previous studies have explored agent interests in UGS, including governments, public, and groups of developers and environmentalists. However, only a few research studies have been targeted to understand the overall interest equilibrium under a system-wide context or to linking empirical differences with a theoretical basis. Aiming at achieving a well-designed UGS planning layout, the theoretical framework of Mechanism Design (MD) contributes a tool to demonstrate how to balance the interests of different agents who have their own utility expectations through designing mechanisms or incentives, toward the desired objectives. The mechanisms in this study are structured in three levels of institution, market and participation planning, and the research gaps in each level of mechanism are interpreted above in Section 2.5.3, Section 2.5.4 and Section 2.5.5. Firstly, in worldwide scope, understandings about the influence of institutional factors on government attitudes to public UGS are insufficiently presented in earlier research studies. Secondly, confronting the failure in the implementation of green plans, little has been done to explore the mechanism that target at maximising public welfare in UGS development through balancing the long-term interests and relationships among different agents. Thirdly, the planning process with participation is important to integrate the opinions of different agents in UGS planning; however, previous studies lack any

inter-city comparison. Specifically, the question of whether good participatory planning approaches in some green cities could be transferred to other cities, is to be further explored, together with the differences of the public opinion among cities regarding their preferences to UGS planning.

In short, this research focuses on two main research gaps in the provision of public USG provision: (1) theoretical-based worldwide mechanisms; and (2) cross-city comparative research. The former requires a theoretical basis to better understand the mechanisms of UGS provision beyond city boundary. The latter, identified as non-studied area in a review article, will help to improve knowledge of underrepresented areas and give insights into the different challenges posed by urban green space preferences, use, or planning objectives, (Kabisch et al., 2015). The combination of Mechanism Design (MD) with case studies is applied to fill these two research gaps, following which the research framework is established in the next paragraphs.

The understanding of agents' interests is the basis of MD, while the question of how different interests are weighted to form the cooperative solution embrace the output of the designed mechanism (Rausser et al., 2011). For each case, the provision of UGS involve N agents: I= {1,2, …,N}, either participating in making the decision or will be affected by the GS. They include government, the public, and other market actors, such as land owner, house buyers, etc. For each agent $i \in I$, Q_i is the probability that the public UGS is produced (Borgers, 2015). In this study, Q_i is a function of the type θ_i and the weight w_i, where type θ_i related to agent i's valuation/preference of the UGS in land use development, and weight w_i implies how much influence the agent could impose on the decision of UGS provision. $T_i(\theta_i)$ is the expected value of the transfer that agent i makes to the community/city, conditioning on agent i's type being θ_i. The expected utility function of Agent i is defined as:

$$U_i(\theta_i) = \theta_i * Q_i(\theta_i, w_i) - T_i(\theta_i) \qquad (2.5)$$

UGS is provided for the public. In this research framework, local government or the mechanism designer's objective is not to maximize the expected value of social welfare ($\max \sum_{i=1}^{N} U_i(\theta_i)$) for the whole society including public, market and even government, but to maximize the expected public welfare for the public who are the end users of UGS. Assigning P as a set of public agents, only the utility of agent i is included, where $i \in P$ will be counted in the objective function. However, for all the agents, the designed mechanism is restricted to be incentive-compatible and individually rational. The object of the designed mechanism is set as:

$$max \sum_{i=1}^{N} U_i(\theta_i) \qquad for\ all\ i \in P$$

$$Constraints: \theta_i Q_i(\theta_i) - T_i(\theta_i) \geq \theta_i Q_i(\theta_i') - T_i(\theta_i') \quad for\ all\ i \in I \qquad (2.6)$$

$$U_i(\theta_i) \geq 0 \quad for\ all\ i \in I$$

The outcome of the mechanism is an expected UGS pattern. In land-use planning and development, the utility of agent i is associated with the spatial features. For example, the performance of UGS pattern is determined by the parameters of UGS percentage, the accessibility of GS, the quality of GS, etc. The operation of existing planning and development mechanism may not lead to the expected UGS pattern; therefore, a new mechanism will be designed. The theoretical framework for applying MD theory to UGS provision is illustrated in Figure 2.5. The framework was inspired by the Figure of "***Mechanism design environment***" in the book "*Game Theory and Mechanism Design*", which presents a clear picture about the components in a mechanism as well as their relationships in the operation of a mechanism (Narahari, 2014).

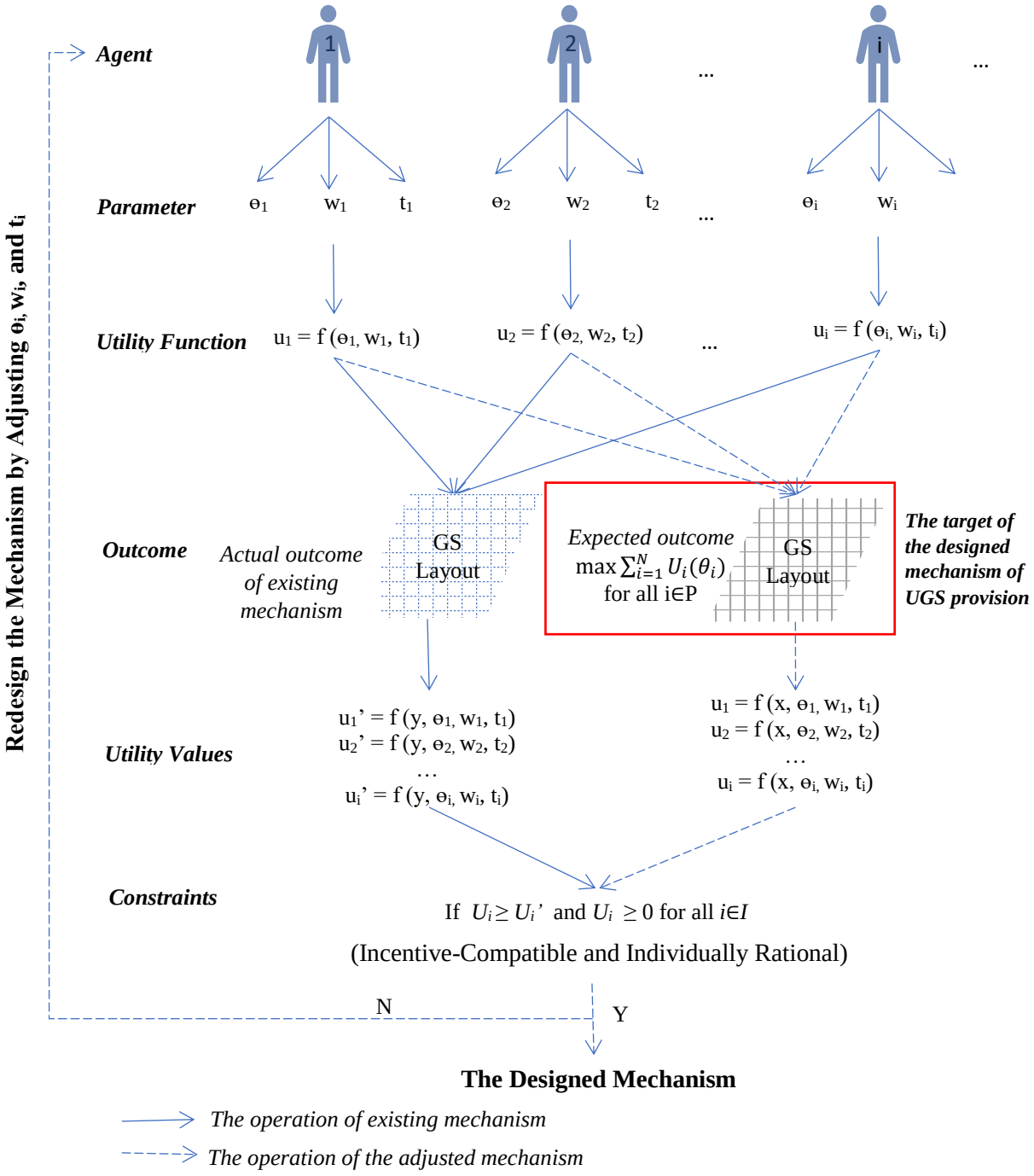


Figure 2.4 The theoretical framework for applying MD theory to UGS provision

(Adopted from Narahari (2014) and manipulated by the author)

According to the theoretical framework above, the design of the mechanism aims at the outcome with maximum public welfare regarding UGS provision in land use planning and development. The mechanism could be designed by adjusting the parameters related to their utility functions, including agents' preference (θ_i), their impact on land-use decision-making (w_i), or the transfer of their benefits (t_i). In simple terms, it is to get the expected UGS outcome without compromising the utilities of agents through incentive designs.

It is hypothesised that the differences in planning outcomes are associated with the characteristics of mechanisms. In the provision of UGS, local policies inter-depend with the environment of the city in various dimensions (Choumert, 2010). The understanding of the system-wide environment is essential to design the incentive-compatible mechanism of UGS provision regarding a specific city. Regarding UGS provision, an incentive-compatible mechanism should be designed based on the roles of agents, their interests, and their utilities in the outcome. Taking the planning outcomes of UGS layouts as the research objectives, agents, by playing their roles in decision-making, lead to the planning outcomes. The process of decision-making is ruled by mechanisms, where governments act under an institutional mechanism, the public act under a participation mechanism, and agents in land market act under a market mechanism.

As illustrated in Section 2.5.2 and Figure 2.4 (Conceptual model for real estate development and the hierarchical mechanisms of urban development), the mechanism of urban as well as UGS development is structured from the top down as three levels, namely: - institutional mechanism; market mechanism; and agent acting mechanism. However, in mechanism design, particularly for the provision of public goods, an expected outcome is designed before the agents' game in the market. To follow the principle of mechanism design, public expectations and planning participation mechanism are given higher priority than market gaming in the research framework of this study (presented in Figure 2.6 where planning mechanism assigned at the middle level), instead of following the hierarchy of development mechanisms (Figure 2.4 where planning mechanism assigned at the bottom level).

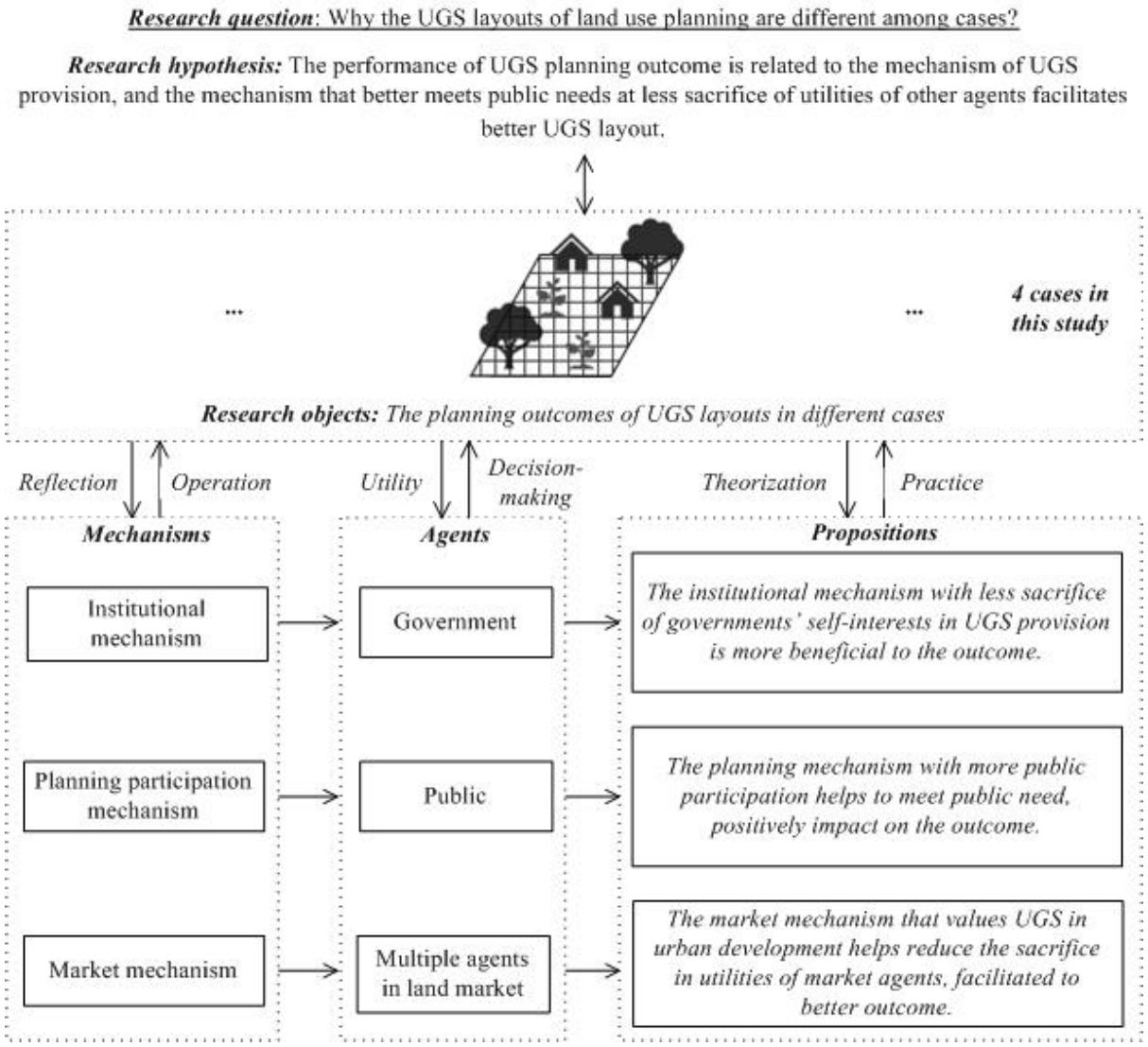


Figure 2.5 The research framework for analysing the mechanism of UGS provision

As illustrated in the Figure above, the institutional mechanism, participation mechanism and market mechanism are the three components in MD concerned in this study, while the Key Agents are at the core of analysing the characteristics of each mechanism. Although the planning processes vary in different cities, it generally starts from a proposal, followed by decision-making, mostly with participation, and ends with a statutory plan as output. The development commitment, also considered as the implementation of the plan, is processed through land acquisition, construction, and marketing and disposal (Adams, 2012). However, what make the outcomes different are the characteristics of the mechanisms, e.g. institutional mechanism, participation mechanism and market mechanism, since they influence the preferences of agents (θ_i); their impact on land-use decision making (w_i); and the rules of transferring their benefits (t_i). The proposed framework aims to identify the system-wide

mechanisms of land resource allocation in agent-based perspective, which will help to answer the research question “why the planning outcomes of UGS layouts are different among cases?”

CHAPTER 3 RESEARCH METHODS

3.1 Types of Research Methods

3.1.1 Comparative case study

The use of a case study, defined as empirical inquiry that investigates a phenomenon or setting, is a robust research method in social science, e.g. in the area of urban planning and design. It is advantageous in exploring the embeddedness of the case in its context, explaining causal links, broadly involving multiple data sources, and it gives the potential to generalize to theory compellingly and convincingly if done well (Groat & Wang, 2013). In contrast to a single-case study that investigates socio-physical phenomena and uncover the complex dynamics of one setting of interest, a multiple-case study together with comparative study highlight the variations in the importance of identifiable factors (Groat & Wang, 2013). Focusing on generalization from cases, a comparative study beyond the geographical borders of the field research is given attention (Steinberg, 2015). However, it difficult to do well in terms of depth, complexity and the multifaceted quality of the case-study. A good comparative case-study requires careful thinking through both the overall framework and the details of the research design (Groat & Wang, 2013).

Case selection in case-study research has two objectives: a representative sample and useful variation on the dimensions of theoretical interest. Instead of choosing cases randomly, techniques of case selection are emphasized and could be categorized in seven types of typical, diverse, extreme, deviant, influential, most similar, and most different (Gerring & Cojocaru, 2016; Seawright & Gerring, 2008). The technique of selecting diverse cases is adopted in this study, under the research objectives and the research framework. The comparative study of diverse cases, which means two or more cases that exemplify diverse values of independent variables (X), dependent variables (Y), or relationship (X/Y), is widely used to explore X or Y or to confirm (hypothesis testing) a particular X/Y relationship (Gerring & Cojocaru, 2016; Seawright & Gerring, 2008). The table below lists a few research studies that have used a comparative study of diverse cases as their research methods.

Table 3.1 Examples of diverse case study in previous researches

Title	Aim	Research Question	Reference

The Acceleration of Urban Sustainability Transitions: A Comparison of Brighton, Budapest, Dresden, Genk, and Stockholm	To study the dynamics of urban sustainability transitions in a diverse range of city-regions to test and refine our theoretical propositions on the acceleration of urban sustainability transitions.	What are the conditions that enable and hinder the acceleration of sustainability transitions? What are the commonalities and differences between the dynamics?	(Ehnert et al., 2018)
The "local turn' in historical perspective: two city case studies in Britain and Germany	To provide an insight into local-level migration and integration policies by exposing the 'local turn' in two European cities, Newcastle in Britain and Bremen in Germany.	How and why do cities react to the challenges of migration and integration, and what is the relationship between the local and national levels of government?	(Hackett, 2017)
Space use optimisation and sustainability - environmental comparison of international cases	To testify the propositions about the impact of intensive and multiple use of space through practical cases of urban planning around railway stations.	Can substantial environmental benefit be created by means of intensive and multiple use of space?	(De Wilde & Van Den Dobbelstee n, 2004)
Strategies for relating diverse cities: A multi-sited individualising compa rison of informality in Bafata, Berlin and Tallinn	To combine the three regionally and thematically diverse cases for understanding informal practices in each of them and to contribute to current understandings of urban informality.	Are the propositions (about the impact of legal systems, diverse interests of institutions, and conflicts between state regulations and alternative norms) held true across the three cases in terms of informality?	(Tuvikene et al., 2017)
Transformation of deprived urban areas and social sustainability: A comparative study of urban regeneration	To understand how urban regeneration and urban redevelopment are embedded in a particular locality and what	What are the purposes and the consequences of urban regeneration and urban redevelopment in different cases?	(Križnik, 2018)

and urban redevelop-ment in Barcelona and Seoul	consequences they have on social sustainability.

From the above list, diverse cases are generally selected cross countries or even continents, to testify the designated hypothesis in a cross-border perspective. In addition, for each study, the number of cases range mostly from two to five, depending on the focused research purposes. Regarding the mechanism of public UGS provision, X is a set of variables that reflect the characteristics of the mechanisms structured in three levels of institution, market, and planning participation. Y is the outcome of UGS layout in the real-world that is constant for a particular case. The purposes of this research are firstly to identify potential X, and secondly to explore X/Y relationships. Hong Kong (HK) is a city confronting insufficient UGS provision in urban areas and an unequal distribution of public UGS. Taking HK as the base case, three more cases will be selected in accordance with the three aspects of mechanisms. The figure below shows the criteria for case selection.

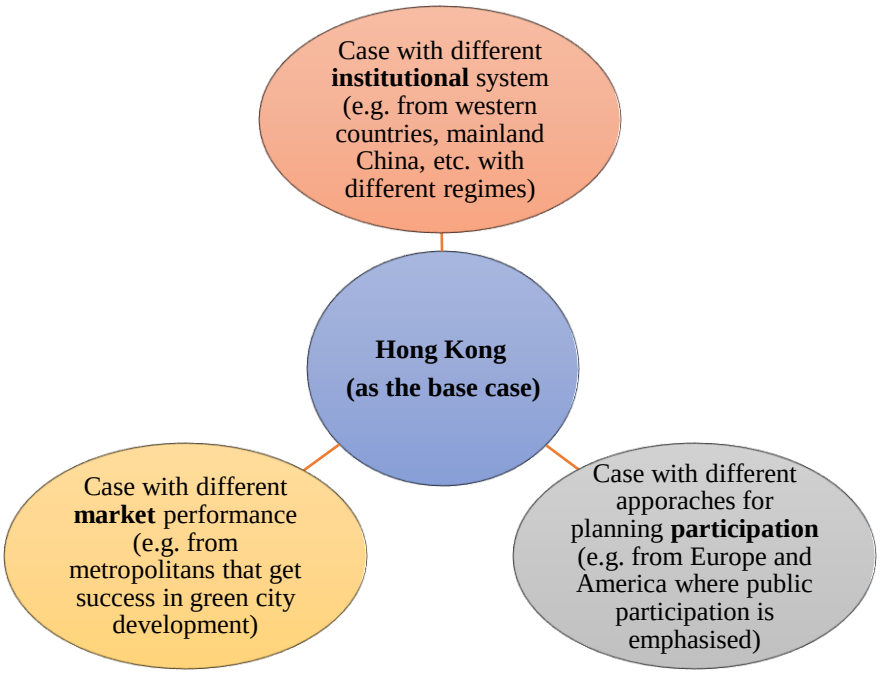


Figure 3.1 The criteria of case selection in this study

Accordingly, at least four cases should be included in this research, one from HK, one from mainland China, two from Europe or America with one representing better performance and one representing worse performance than HK, regarding green city development. Details of case selection will be introduced later in Section 3.2.1. To conduct case studies, mixed research methods and strategies are often employed to marshal the benefits of two or more research

designs using a variety of data collection and analysis tactics (Bryman, 2016; Groat & Wang, 2013). In the following section, how the methods are combined to address the research questions in this study is introduced.

3.1.2 Quantitative and qualitative methods

The most distinct difference between quantitative research and qualitative research is that the former uses measurement while the latter does not. To think it deeper, quantitative research emphasizes quantification in the collection and analysis of data that entails a deductive approaches to the relationship between theory and research, incorporates practices and norms of scientific model, and embodies social reality as objective reality; by contrast, qualitative research emphasizes words that entails an inductive approach to the relationship between theory and research, emphasizes individuals' interpretation of their social world, and embodies social reality as an emergent property of individuals' creation (Bryman, 2016).

In this study, multiple methods are applied to demonstrate the characteristics of different mechanisms and the relationship between their characteristics and the UGS planning outcome. Generally, the characteristics/attributes of a mechanism could be interpreted in a qualitative approach, e.g. by identifying influential factors and demonstrating the influence of the factors on the outcome. However, since the provision of UGS is a complex process, that is subject to the hierarchical mechanisms with multiple agents involved, it is essential to combine both the quantitative and qualitative research methods to demonstrate the mechanisms. Based on the targeted research questions, the research methods in this study are defined, shown in Table 3.2.

Table 3.2 Research methods applied corresponding to the research questions

Research question (raised in Section 1.2)	Research method	
	Quantitative research	Qualitative research
What factors are the influential to the attributes of a mechanism?	Mixed methods: interpreting and summarising based on mutual analysis of results in quantitative and qualitative research	
What are the current processes and rules of UGS provision in the selected city cases, and how are the mechanisms differentiated?		Documentary analysis and interviewing (focusing on the dynamic processes)
Do the attributes of a mechanism relate to the performance of the UGS layouts? If yes, how are they related?	Structured correlational analysis in three aspects of institutional, planning participation and market mechanisms	

Who are the agents (government, public, developer, etc.) running the mechanism?		Documentary analysis and interviewing
What are their preferences and how do they play their roles in planning and development process?	Self-administered questionnaires and statistical analysis (for public)	Interviewing (for government, developer, etc.)
What is the relationship between their utilities in UGS provision and the mechanisms?	Correlational analysis and spatial simulation	
What are the difficulties/barriers in optimizing UGS provision?		Logical argumentation
For each case/mechanism, what are the advantages and the encountered restrictions?	Mixed methods: comparison based on the results of both quantitative research and qualitative research	
What are the approaches for overcoming the restrictions?		Logical argumentation

Overall, the main method used throughout this study is comparative case study. To illustrate the cases and compare their differences in UGS provision, both qualitative and quantitative methods are applied. Qualitative methods of field survey, documentation, and interviewing are used for cases study; whereas some parts of the questionnaire are quantitatively analysed by mathematical statistics. Quantitative methods of questionnaire and statistical analysis, agent-based analysis, and agent-based cellular automation model are adopted for case comparison. More details of the methods are explained in the following sections.

3.2 Case Study

3.2.1 Selection of four cases

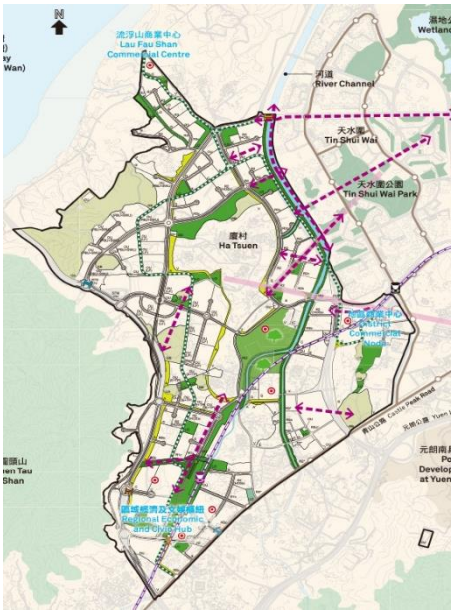
Land use planning patterns of development projects in different cities are the subjects (Y) to be studied. In addition to the criteria of case selection illustrated in Figure 3.1, comparative study requires both similarities and differences to be explored in cases. The principles adopted in selecting cases are identified as:

a. Type consistency - the case should be a development project located at the urban fringe area (urban expansion/densification area) of a growing metropolis;
b. Time consistency- the project should be ongoing, either at planning stage or development stage;
c. Diversification - the cases should be selected from different regions/countries, yet with some common parameters in term of scale, provisions of UGS and stakeholders in involvement, etc.; and

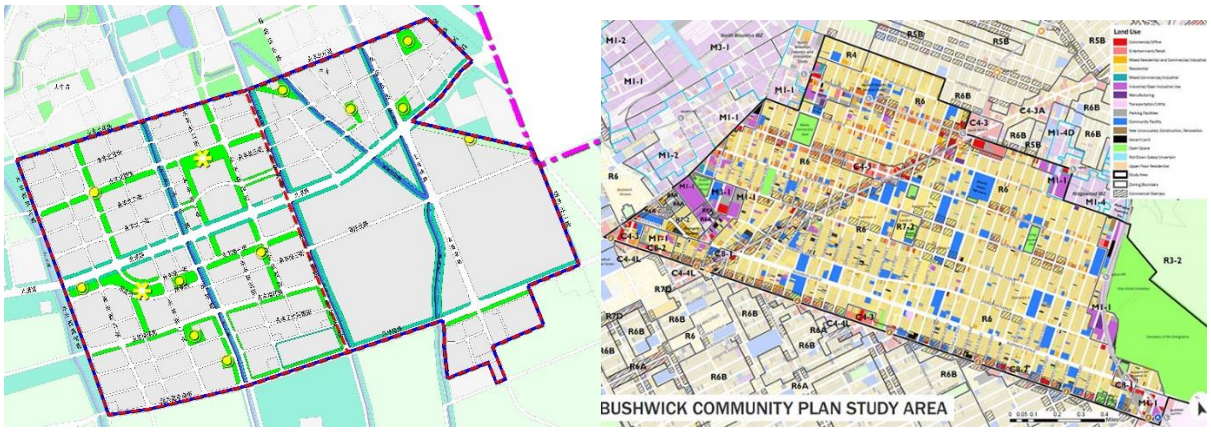
d. Data availability - field survey, documentation, interview and questionnaire investigation could be conducted to collect requested data.

Adhering to the above principles, four cases of development projects were selected for analysis, namely: 1) Haidian North District in Beijing (China); 2) Hung Shui Kiu New Development Area in Hong Kong (Special Administrative Region, China); 3) Bushwick in Brooklyn, New York (US); and 4) Aspern Seestadt in Vienna (Austria). Corresponding to Figure 3.1, the case in HK is taken as the base case, the cases in Beijing, New York and Vienna emphasise the variations in institutional arrangement, planning participation, and market performance, respectively. However, it is difficult to control the dimension of the differences among cases, e.g. although the case in New York is selected due to its different attributes in planning participation mechanism compared to HK, it could also be distinguished from HK in the aspect of institutional mechanism. Similar situations happen to cases in Beijing and Vienna. Since X consists of variables in three levels of mechanisms and the variables jointly impact on the outcome Y, the four cases could hardly be separated, yet analysed in each level of mechanism.

Among the four cases, the type of case Bushwick may be doubted as it is a well-developed area in New York. However, in contrast to the urban centre of Manhattan and district centre of Brooklyn, Bushwick could be regarded as fringe area where there is a need and space to increase the development density and rezone land uses. The UGS planning layouts of the selected four cases are shown in Figure 3.2. Why the UGS provision of the four cases are different is a question of particular focus in this research.



(a) HSK[1] in HK **(b) Aspern Seestadt[2] in Vienna**



(c) HDN[3] in Beijing **(d) Bushwick[4] in NYC**

Figure 3.2 The UGS planning layouts of the selected four cases

Note: Legends of types of UGS are extracted as
Layout (a): green-open space(OS), light green-green belt(GB), yellow-amenity area;
Layout (b): light green-central lake, green-OS, dark green-GB, yellow-playground;
Layout (c) and (d): green-GS

3.2.2 Document analysis

Based on collected documents (mostly from websites), the four cases of urban-fringe development projects in different cities are selected as their mechanisms of UGS provision are clearly demonstrated, which assists in our understanding. The planning principles regulate the standards of UGS provision. The key documents regarding the planning principles in the four cities are summarised below.

Hung Shui Kiu (HSK) in HK

In HK, the "Hong Kong Planning Standards and Guidelines" set out the standards for urban planning and design. In the urban areas, including the Metro Area and the New Towns, the standard for provision of open space is a minimum of 20 ha per 100 000 persons i.e. 2m^2 per person, apportioned as District Open Space (DO) and Local Open Space (LO) by halves. Green Space such as Amenity Areas, Country Parks, Green Belts and Coastal Protection Areas, which do not readily lend themselves to the formulation of any standards, are excluded. See Table 3.3.

[1] Hung Shui Kiu New Development Area Planning and Engineering Study – Investigation, April, 2017 http://www.hsknda.gov.hk/files/sotr/Executive%20Summary%20(EN).pdf
[2] Wien 3420 Aspern Development AG, Vienna. https://www.aspern-seestadt.at/
[3] Beijing Municipal Institute of City Planning & Design. http://www.bjghy.com.cn/ghyEng/ghyEng1profile.aspx
[4] The Department of City Planning, New York City. https://www1.nyc.gov/site/planning/plans/bushwick-neighbourhood-plan/bushwick-neighbourhood-plan.page

Table 3.3 Green and open space provision standards for HK urban area[5]

Open Space Category	Provision Standard	Remarks
Regional Open Space (RO)	No standard	- Large scale open space in urban areas or at urban fringes to serve territorial population and tourists - Building site coverage ≤ 20% to allow for special built facilities - Provides as a 'bonus' above the minimum standard - 50% counts as District Open Space in the Metro Area
District Open Space (DO)	10 ha per 100 000 persons (i.e. 1m^2 / person)	- Building site coverage ≤ 10% Subject to slope correction factor - Active/passive ratio is applied - Not applicable to industrial, industrial-office, business and commercial areas, rural villages and small residential developments in the rural areas
Local Open Space (LO)	10 ha per 100 000 persons (i.e. 1m^2 / person)	- Subject to slope correction factor - Building site coverage ≤ 5% - No active/passive ratio - Primarily for passive use - In industrial, industrial-office, business and commercial areas, the standard is 5 ha per 100 000 workers (i.e. 0.5m^2 per worker)

Source: Hong Kong Planning Standards and Guidelines

According to the standard, with 218,000 population, the area of HSK should provide a minimum of 43.6 ha open space. Referring to the recommended outline development plan of HSK, the total area of open space is 66 ha, consisting of 16 ha of RO, 27 ha of DO, and 23 ha of LO. Both the apportioned and overall standards for the provision of open space are satisfactory. If counting amenity area (18 ha) and green belt (54 ha) into UGS provision, the total green area will be 132 ha.

Haidian North (HDN) in Beijing

[5] Chapter 4 : Recreation, Open Space and Greening, Hong Kong Planning Standards and Guidelines (HKPSG), http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch4/ch4_text.htm

Two categories of UGS were planned in HDN, namely park land and green buffer. According to "Beijing Green Space System Plan"[6], the average park land area per capita should be 15~18 m^2. In the Beijing Urban Master Plan (2016-2030) which is recently announced as the guidance for long-term development of Beijing, park land per capita is planned to increase from 16m^2 in 2015 to 16.5m^2 in 2020, and further 17m^2 in 2035. This standard is much higher than those in HK.

Seestadt in Vienna

Based on "STEP 2025: Urban Development Plan Vienna", the thematic concept of "Green and Open Spaces" was developed in 2015, as a guideline for future open space supply where the latest "Green and Open Space Standard for Vienna" was announced.

Table 3.4 Green and open space standards for Vienna

Green and open space	Catchment area (m)	Sizes (hectare)	m^2 per inhabitant		
Neighbourhood	250	<1	3.5		
Residential area	500	1-3	4.0		
Urban quarter	1000	3-10	4.0	8.0	13.0
	1500	10-50			
Region	6000	>50	5.0		

Source: Thematic Concept Green and Open Space, STEP 2025, Vienna City Administration Municipal Department 18 (MA 18) – Urban Development and Planning

Bushwick in NYC

According to the "Urban Design Principles for Planning New York City" the City uses policy and zoning tools to improve individuals' access to quality open space. For instance, access to quality open space can be limited when cars are given priority over pedestrians and bicycles. Urban design improves accessibility and openness by designing places that encourage public use, ensuring that privately-owned public spaces and waterfronts are both visible and welcoming to passers-by.[7] In New York City, the Department of City Planning and the Department of Parks are responsible for providing of recreational and athletic facilities and programs. Rules and Regulations are mainly for parks management such as the use of the park,

[6] http://hd.bjghw.gov.cn/web/static/articles/catalog_48100/article_ff80808138cc799d0138ff37b5a800d0/ff80808138cc799d0138ff37b5a800d2.pdf

[7] http://www1.nyc.gov/site/planning/plans/urban-design-principle/urban-design-principle.page

permits and fee schedule, etc.[8] However, no regulatory planning principles were found from the two departments in terms of the total area of UGS or average area per capita.

The performance of UGS layout could be evaluated in multiple dimensions. The characteristics of urban vegetation have been defined by two parameters, i.e., the amount of green and type of green to calculate of Green Index (Gupta et al., 2012). More diversified criteria were established in three aspects with indicators: quantity (UGS per capita, UGS percentage, and UGS per urban land), accessibility (total population and communities within service scope of UGS), and quality (area-weighted shape index, splitting index, Euclidean nearest neighbour distance, and patch density) (You, 2016). Based on the collected data, three criteria of quantity (R_g: UGS percentage in the study area), accessibility (percentage of built-up land within walkable distance of UGS), and quality (the diversity in the types of UGS) are used to evaluate of UGS layouts in the 4 cases.

To identify the walkable scope of UGS, previous research studies are referred. A study in the U.S. found that walking distances varied substantially by purpose as well as by socio-demographic characteristics, with the average distances of 0.47 miles (756 metres) observed for recreation trips (Yang & Diez-Roux, 2012). In some recent researches regarding human interaction with UGS, the walkable scope is defined as a 500m buffer area (Kytta et al., 2016; Rupprecht et al., 2015), a limit which is adopted in this study. Since the variation in Accessibility of the four cases is much less than the variation in R_g, R_g is most influential to the performance of UGS layout, followed by Diversity. Objectively, the performances of layouts as the outcomes (Y) are ranked as Seestadt (1st), HSK (2nd), HDN (3rd) and Bushwick (4th), from best to worst. The results of the comparison are demonstrated in the table below.

Table 3.5 The comparison of the UGS layouts in the four cases

Case	HSK	HDN	Seestadt	Bushwick
R_g*1	19.2%	15.5%	26.5%	2.3%
Accessibility*2	96%	99%	96%	95%
Diversity*3	mix	simplex	mix	simplex
Overall Rank*4	***2nd***	***3rd***	***1st***	***4th***

Notes:

*1: calculated in ArcGIS and verified by related documents

*2: the percentage of land areas within the walkable scope (<500m) of open space in the study area

[8] https://www.nycgovparks.org/rules

*3: categorized by the types of UGS

*4: based on the former three criteria

The high-quality standard of UGS planning is assumed to be comprehensive and beneficial to green environment, with multiple parameters in different scales. Therefore, the quality of the standard is ranked as Seestadt (1st), HSK (2nd), HDN (3rd) and Bushwick (4th), from best to worst. In addition to regulations, other documents related to land development, planning participation, and other pertinent information associated with the cases/cities are presented or analysed in the corresponding sections.

3.2.3 Field survey and interview

Interviews were used to elicit data about how the current worked and what are agents' roles and interests in UGS provision. Interviewees included government officers, politicians, developers, etc. who are either the principal of UGS provision or belonging to the special-interest groups of development or amenity. Since governments are the principals in UGS provision, the interviews with government officers are essential for each case. Questions discussed during interviews are related to the planning process, agent aspirations in land development, agent roles in UGS provisions, and strategies used in UGS provision, etc.

Formal emails were sent to the Planning Departments of the four cities with a request to consult them about their plans, including a question list and invitations for face-to-face interviews. The responses were varied. The Planning Department of HK replied and answered some of the questions by email. Departments in Vienna and NYC accepted the invitation of the interviews. The email to Beijing had not been responded to for over two weeks and so a reminder mail was sent. In the meanwhile, interview requests were also delivered through the researcher's personal network. Both the approaches worked. In addition to consulting governmental departments, some other agents such as councillor, expert and developer (in case of Seestadt that is already under construction) were interviewed to know their understanding of and attitude to the plans. More information about the interviews is given in the following table.

Table 3.6 Basic information of the interviews

Case	Position	Date	Language
HSK, HK	Expert panel member of the HSK Study	April, 2016	Chinese and English
	District Councillor	May 4th, 2016	Chinese (Cantonese)
	District Councillor	May 9th, 2016	Chinese (Cantonese)
HDN, Beijing	Project leader in Beijing Municipal Institute of City Planning & Design	November 10th, 2017	Chinese (Mandarin)
Seestadt, Vienna	Principal Staff in Wien 3270 (the development company of Seestadt)	October 6th, 2016	English

	Project Manager in Planning Department of Vienna	October 12th, 2016	English
Bushwick, New York	Principal Staff in Planning Department （in charge of Bushwick Community Plan）	April 20th, 2017	English
	Principal Staff in Parks Department（in charge of Bushwick Community Plan）	April 17th, 2017	English
	Member in the District Councillor Office （in charge of Bushwick Community Plan）	April 24th, 2017	English

Contents extracted from the interviews are attached in Appendix A: Interview Questions and Answers from the Interviewees.

3.2.4 Questionnaire survey with public

Questionnaire surveys are conducted to know peoples' preferences in land use planning and development. In this study, the questions include what their perceptions to UGS are, what are the importance of different land use to agents, what factors agents concern about, have they and how they participated in planning process, etc. The questionnaire was analysed in mathematical statistics to reveal the different considerations among respondents in the four cities. The results were then compared with the land use pattern to show how their considerations are reflected in the project, to evaluate the performance of participation mechanisms. Details of the questionnaire design, data collection (such as how and to whom the questionnaire was distributed and to how many) and analysis of the data are explained in Section 5.3 and Section 5.4.

3.3 Cross-sectional Comparative Study

Cross-sectional and time-series analyses are two major approaches used for comparative study. Rather than tracing the changes through time (time-series analyses), normally a cross-sectional study is used to sort out the existence and magnitude of causal effects at a given point in time. To compare the UGS layouts of the four cases, methods of agent-based model and agent-based CA model are applied.

3.3.1 Agent-based modelling (ABM)

Land use is never static, but it is constantly changing in response to dynamic interaction between drivers and feedback from land-use change to these drivers. The agent-based perspective is centered on the general nature and rules of land-use decision-making by individuals (Lambin et al., 2003). Agent-based modelling (ABM) is an approach that has been

receiving attention by the land use modelling community in recent years. ABM is a computerized simulation of a number of agents which interact through prescribed rules, and such agents are embedded in and interacting with a dynamic environment, having the capacity to learn and adapt in response to changes in other agents and the environment (An, 2012). This offers specific advantages of agent-based models, that include their ability to model individual decision-making entities and their interactions, to incorporate social processes and non-monetary influences on decision-making, and to dynamically link social and environmental processes (R. B. Matthews et al., 2007). With ABM, the researcher explicitly describes the decision processes of simulated actors at the micro level. Developing such models requires gaining information about how agents make their decisions, how they forecast future developments, and how they remember the past. What do they believe or ignore? How do agents exchange information? Does the structure of agent interactions affect the macro-level scale phenomena? (Janssen & Ostrom, 2006).

Agent-based land-use models are particularly well suited for representing complex spatial interactions under heterogeneous conditions and for modeling decentralized, autonomous decision making, in which the cellular model is part of the agents' environment, and the agents, in turn, act on the simulated environment. The complex interactions among agents and between agents and their environment can be simulated in a manner that assumes no equilibrium conditions. Rather, equilibria or transient but re-occurring patterns emerge through the simulated interactions between agents and their environment (Parker et al., 2003).

In terms of decision support, agent-based land-use models are useful as research tools to develop an underlying knowledge base which can then be developed together with end-users into simple rules-of-thumb (R. Matthews et al., 2007). To measure the performance of four planning landscapes, an agent-based model was established using Netlogo. Interests of agents such as government, developer and residents are variables in the model, and how their interests are associated with the UGS provision were analyzed. For each landscape, the land was subdivided into cells, with each cell acting as an environmental agent containing the values of variables. How agents interact with each other to make decisions, and how human interact with the environment would be reflected in the designed agent-based model, representing different decision-making mechanisms and the effect of different land use patterns on agents' utility.

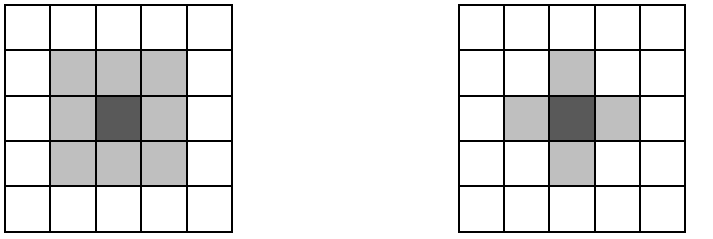
3.3.2 Agent-based Cellular Automation modelling (ABM-CA)

When involving spatial data, an ABM-Cellular Automation (CA) model would be built. An

agent-based CA land-use model combines a cellular landscape model with agent-based representations of decision-making, integrating the two components through specification of interdependencies and feedbacks between agents and their environment, and offers a promising new tool to create fine-scale models of land-use change phenomena that focus on human-environment interactions (Parker et al., 2003).

CA was thought initially as a dynamical spatial system in which the state of each cell in an array depends on the previous state of the cells within a neighbourhood of the cell, according to a set of state transition rules (White et al., 1997). A more detailed explanation is that with discrete spatial units as the basic units of simulation, such as shaped pixels, parcels, or other land units arrayed in a tessellation, CA models use a variety of input information to simulate the conversion of land cover or land-use in these land units. The model is based on a rule set or algorithm that is applied synchronously to all spatial units and that it represents the modeller's understanding of the land change process (National Research Council (2014)). There are mainly four crucial elements in the model's application process: cells and neighbourhood, transition rules, calibration, simulation and validation.

Formal CA assumes a cell space represented by a regular grid usually composed of square cells and the cell space is homogeneous (Sante et al., 2010). In the conventional ad hoc way, the land is divided to N*N grid, e.g. through a 3×3 kernel.



Moore neighbourhood von Neumann neighbourhood

Figure 3.3 Examples of neighbourhood in CA models

For cells in different size, the feature spatial accuracies are also varied. The smaller the size, the more accurate the features will be. The specified shape of the neighbourhood restricts how far and where to look for the measured values to be used in the prediction. The neighbourhood could be composed of the geometrically closest set of cells in different methods, such as Moore and von Neumann neighbourhood. However, in this study, neither Moore nor von Neumann neighbourhood are adopted, since the cells are mainly identified by their planned uses.

Transition rules determine how the model will be run. It is the regulation of neighbourhood transition potentiality for each unit of land or cell with specific use, showing the

probability/regulation of this unit land transferred to other uses. There are some different formulations for calculating the neighbourhood potentiality, such as the Percentage (development degree), Regression (transition probability related to site attributes), Inherent suitability (suitability for a specific use) and other rules (Sante et al., 2010; Wu, 2002). To overcome the drawbacks of accuracy and model size, recently, a number of authors have studied the application of more efficient heuristic methods such as genetic algorithms, simulated annealing or neural network. In models that use artificial intelligence techniques to define the transition rules, the design and calibration of the rules occur simultaneously. However, in this study, the site is in project scale and land use situations are relatively simple, and the inherent suitability (whether the cell is planned as UGS use) is considered in the model, followed by some cell attributes such as distance to UGS.

3.3.3 Comparative study

Based on the analysis of four cases, the factors in planning systems, institutional factors such as land ownership, land development process, participation, performance of UGS provision as well as agents' roles and interests were compared, while the advantages/shortages of the mechanisms were identified. These factors form the basic framework to conduct comparative study of these 4 cites. The comparison of the effects of different institution/participation/market mechanisms are the basis of designing incentive-compatible mechanism of UGS provision.

3.4 Methods Specification in Thesis Structure

This section gives more details with respect to the implementations of the methods in this thesis. The thesis structure is further elaborated through specified methods and research questions, in Figure 3.4.

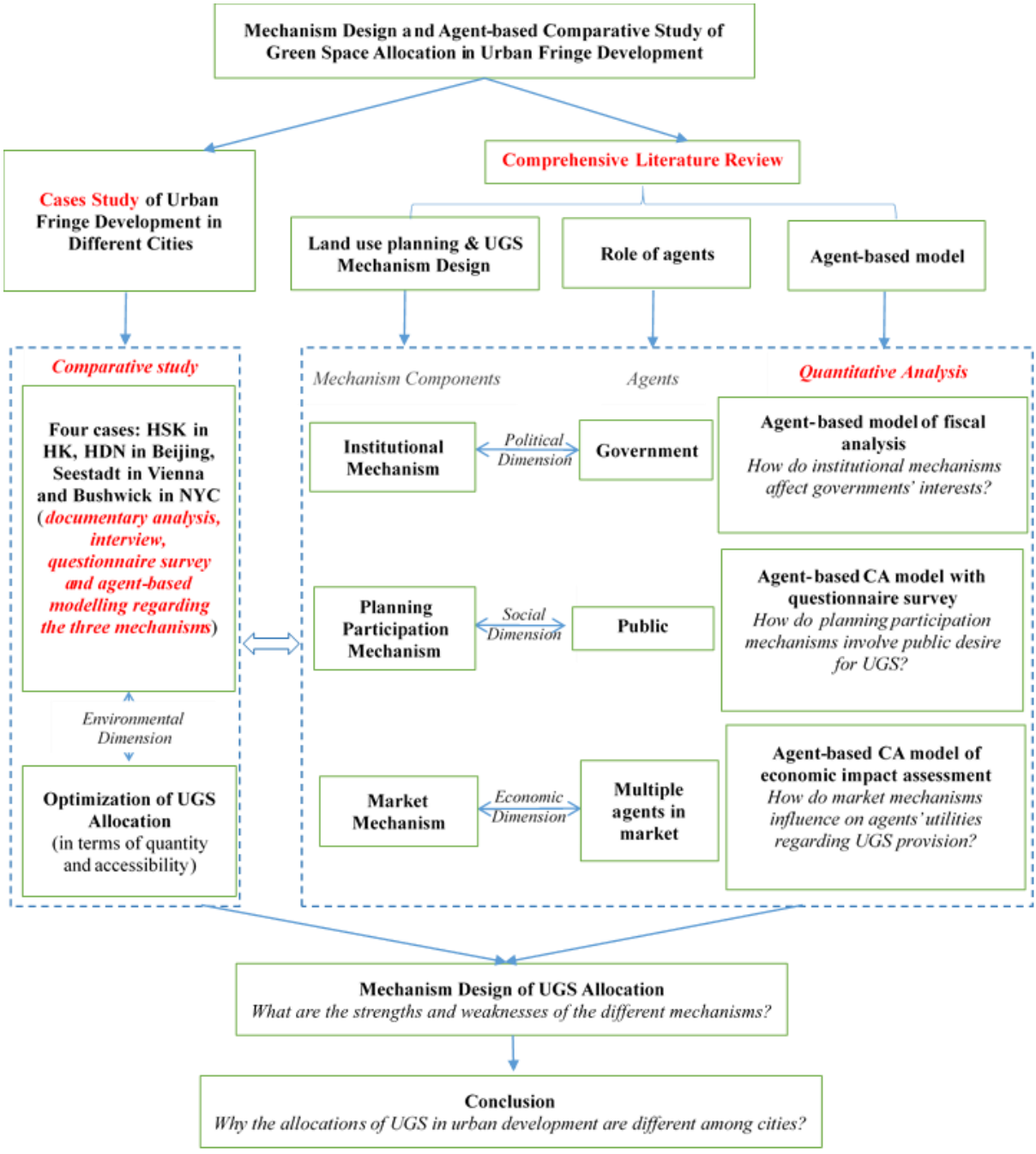


Figure 3.4 Research methods specification in thesis structure (in red characters)

CHAPTER 4 INSTITUTIONAL MECHANISM AND THE GOVERNMENT ATTITUDE TO UGS PROVISION

4.1 Summary of Chapter 4

Institutional arrangements treats institutions as sets of rules, decision-making procedures, and programmes (Young, 2002). In the decision-making of land use and UGS provision, institutional arrangements determine the mechanism or the procedures of land development and affects the outcomes. This Chapter focusing on fiscal effect of institutional arrangements, attempts to explore the relationship between institutional factors and government decision-making of UGS provision, through explaining the characteristics of different arrangements and land development mechanisms. The framework of this Chapter as established, is shown in Figure 4.1.

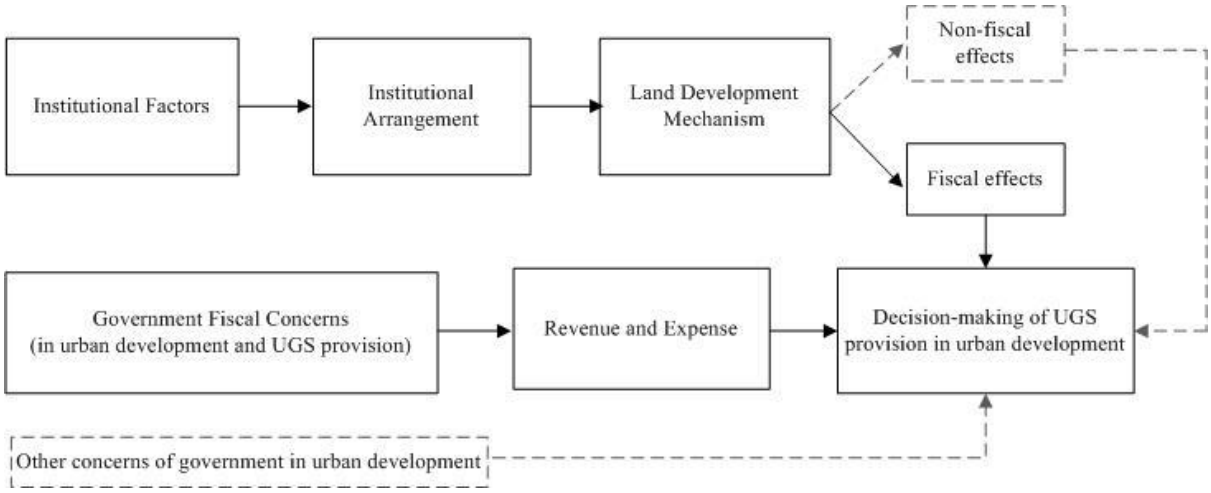


Figure 4.1 The relationship between institutional mechanism and UGS provision

Note: The arrows with solid line "→" indicate the research flow of this chapter in terms of fiscal concerns

In Section 4.2, the institutional factors which are influential to UGS provision are reviewed. Land development mechanisms of the four cases are narrated in Section 4.3 with information from official websites and interviews. Focusing on the institutional factors of property rights and UGS provision instrument, an agent-based model is presented in Section 4.4 to analyse the effect of institutional arrangement on the interests of governments (the principals) under different land development mechanisms. By increasing UGS in the land use pattern, changes in government interests are simulated and compared. Section 4.5 presents the results and discusses the impacts of land development mechanism on principals' attitudes towards UGS

supply.

4.2 Institutional Factors Affecting UGS Provision

Regarding institutional arrangement, influential factors to UGS provision in land development are categorized as institutional structure, initial assignment of property right, instruments and institutional capacity.

4.2.1 Institutional structure

Institutional structure refers to the networks of organization, including all relevant agencies at each level of government, plus non-governmental stakeholders, and it is embodied in the concept and practice of governance (Neuman, 2012). In urban planning, institutional structure, as the backbone of an institution, is a fundamental factor for transnational and historical evolution analysis. Comparative studies of European, Middle Eastern, and Chinese cities suggest a strong relationship between the institutional structure of a society and the form of its urban open space (Alsayyad & Bristol, 1992). Among different levels of federal, state, and local governments, a study of the USA shows the outputs of open space preservation policies were substantively varied associated with respective mechanisms and limitations (Romero, 2003). The relationship of the organizations built in the network is another important attribute of institutional structure. For example, institutional 'schizophrenia', as revealed by the fragmented approach to green infrastructure development, has affected stakeholder collaboration and confidence and the delivery of UGS in the UK (Roe & Mell, 2013).

4.2.2 Initial assignment of property right

Property rights here are defined as formal and informal institutions and arrangements that govern access to land and other resources, as well as the resulting claims that individuals hold on those resources and on the benefits they generate (Musole, 2009; Wiebe & Meinzen-Dick, 1998). Initial assignment of property right or land ownership could be classified into four categories, namely unassigned rights (open access), rights assigned to a group of individuals (collective/communal property), rights assigned to an individual (private property), and rights authorised by public sector (public/state property), with their particular natures and the ways of enforcement impact on resource allocation and economic efficiency (Buitelaar & Segeren, 2011; Feder & Feeny, 1991; Ostrom, 2003). In urban development, the assignment of property rights often regards the whole bundle of property rights, and the initial assignment of rights has both important direct and indirect morphological effects. It can have an important effect on the

financial feasibility and the quality of a project, for instance, to provide less public as a compensation for the financial deficits caused by high land acquisition costs (Buitelaar & Segeren, 2011). How the initial assignment of property right/initial land ownership influences on government revenue/expense in urban development as well as UGS provision is worth an investigation. Apart from initial assignment of property right, delineation of property rights the institutional foundations for the land market and has significant impact on the nature of development process and its consequences (Havel, 2014). However, to distinguish them from the initial landownership, they are regarded as a component of instruments. Focusing on the initial landownership, it raises the question of how the initial property right structure influences government revenue/expense in urban development as well as UGS provision? The analysis later will try to explain this relationship of initial property right structure and government benefit.

4.2.3 Instruments for providing UGS

Instruments, namely the set of techniques by which governmental authorities wield their power to provide UGS, could be classified in three forms which are regulation, public acquisition, or market incentives (Bengston et al., 2004; Romero, 2003). Regulation consists of government placing limits on development and utilizing an administrative and legal system to monitor compliance and impose penalties for violations, such as zoning ordinances (Romero, 2003). Public acquisition of open space is an alternative strategy in which land is simply purchased by the government, thus insuring its protection while eliminating the necessities of monitoring regulatory compliance and potentially high compensatory payments to property owners (Platt, 1996). It is the most certain public policy instrument for protecting open space, but it is also the most expensive to implement (Bengston et al., 2004). Finally, market-based incentives involve either the handing out (incentives) or taking away (disincentives) of monetary or non-monetary material resources in order to change behaviour, but no one is obligated to take a particular course of action (Bengston et al., 2004). For governments lacking resources to commit to regulation or acquisition, this is an increasingly common alternative (Romero, 2003). In the real world, hybrid instruments are sometimes adopted to promote UGS provision, while many of them are associated with the delineation of property rights, such as combining land-use planning and tenure security proposed for developing countries (Chigbu et al., 2017) or exploring time-limited property rights to strength control of building activity in the planning of Switzerland (Gerber et al., 2017). Overall, instruments are diverse and constantly changing with city development contexts.

4.2.4 Institutional capacity

Narrowing down to the local implementation level, the effects of institutional factors could be summarized as governance capacity or institutional capacity. Qualitative index analysis in Albay, Philippines suggested that the institutional capacities of local governments, to influence the behaviour of people and produce collective action, is crucial in the local mainstreaming process (Cuevas et al., 2016). Comparative study of German cities determined that the fiscal resources of cities and the professionalism of local government officials are important determinants of the level of public goods (Ziblatt, 2008). The variation in local responsibility of land planning is significant among Caribbean states, where microstate local government may be politically weak, under-resourced or even non-existent (Wyatt, 2011). In the compact city of Hong Kong, the limited UGS provision could be attributed to low and outdated planning standards for open space, inadequate urban design guidelines, dispersed governance, legal vacuum and little citizen engagement (Jim & Chan, 2016). Institutional capacity may overlap with institutional structure. However, the former emphasises the implementation of plans or policies at a local level, while the latter is applicable in wider range of local, regional, or state regimes. Related institutional factors are summarised in Table 4.1.

Table 4.1 Institutional factors affecting UGS provision (from literature review)

Institutional structure	Initial Property rights	Instrument	Institutional capacity
Historical institutional structure	Open access	Regulatory approach	Fiscal resource
	Public property		Professionalism
Institutional levels and forces	Collective/communal property	Purchase of land	Scale of the city/local area
		Incentive-based instrument	The quality of planning standard and guideline
Structural fragmentation	Private property		Executive capacity
			Citizen engagement

Referring to the four categories of institutional factors, 'initial property right' and 'instruments' of UGS provision are more relevant to the study at city level than other two, while 'institutional structure' is meaningful for transnational, inter-city or transit-time comparison and 'institutional capacity' focusing mainly on intra-city analysis. Institutional mechanisms, the arrangements with different combinations of designated institutional factors, will be compared based on the selected cases.

4.3 Institutional Arrangements for Land Development

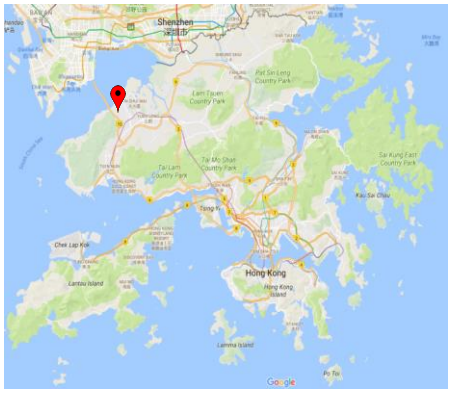
The land development mechanism shows the dynamic urban expanding process of how a piece of land is developed, transferred from original residents to new house buyers, and converted from un-built or low-density built-up land, to high density built-up land. To control the variables for comparison, only residential development was considered in this study, since it is one of the most popular approaches of urban growth, with the dynamic processes of land acquisition, land sale, construction, house sale and property tax collection. The cities of Beijing, Hong Kong (HK), Vienna and New York City (NYC) featured differentiated land development dynamics in the respective public land market and private market, while processed with or without the collection of property tax. The different land development mechanisms of the four cities will be narrated and then compared in this section.

4.3.1 Hung Shui Kiu in HK

The development project of Hung Shui Kiu (HSK) New Development Area (NDA) located in the North West New Territory, HK. Showing a mixed urban-rural character in existing land use, the north of the NDA is predominantly occupied by open storage/port back-up uses whereas the south is mainly occupied by low density residential/village developments with scattered industrial uses.[9] The project covering 7.14 km^2 area, 4.42km^2 of which is for development while others are retained as existing uses such as villages, roads, green belt, etc. The development of HSK aims not only to provide housing and other land supply in HK, but also to serve as a "Regional Economic and Civic Hub" for the North West New Territory. [10]

[9] Hung Shui Kiu New Development Area Planning and Engineering Study Stage 1 –Community Engagement Digest, December 2011

[10] Civil Engineering and Development Department and Planning Department, Hung Shui Kiu New Development Area Planning and Engineering Study. Available at http://www.hsknda.gov.hk/index.html (Accessed: 10 May 2016)



(a) The location of HSK in HK

(b) The scope of HSK NDA

(c) The current land use situation of HSK

Figure 4.2 The location (a), scale (b), and current land use situation (c) of HSK
Source: (a) - Google Map; (b) and (c) - The official website of the project[11]

Completed in 2003, the "Planning and Development Study on the North West New Territories" (the NWNT Study) initiatively identified HSK as a suitable NDA. According to the official website[12], the proposal was revisited officially by the "Hong Kong 2030: Planning Vision and Strategy", “2007-08 Policy Address”, etc., and afterwards, the HSK NDA Planning and Engineering Study (the Study) has being conducted by the Civil Engineering and Development Department (CEDD) and the Planning Department (PlanD) since August 2011. The Study was to be completed in 2017, formulating a recommended outline development plan and layout plans, technical assessments and environmental impact assessment as well as an implementation programme.[13] The “Enhanced Conventional New Town Approach”, which means taking the land resumption (full public approach) as the primary mode with allowance for modification of lease including in-situ land exchange applications, will be the mechanism

[11] http://www.hsknda.gov.hk/# Accessed on September 22nd, 2017
[12] http://www.hsknda.gov.hk/# Accessed on September 22nd, 2017
[13] http://www.hsknda.gov.hk/# Accessed on September 22nd, 2017

to implement the development plan. Divided into 5 stages, the development is expected to be processed in 2019-2038.[14]

In HK, land development for public purpose can be resumed according to the "Lands Resumption Ordinance" (Cap.124). After land resumption, government will be responsible for site formation and engineering infrastructure (advance work of development), and then sell land to developers for private development in according with "Sale of Land by Auction Ordinance" (Cap. 27) in general. In case of land modification, the lot owners and government will negotiate to make agreement on land premium payable for lease modification/land exchange applications, before conducting development work.[15] Once obtaining development right, developers will complete the construction and manage the properties. Since land resumption is the primary model of development, lease modification will be not analysed in this study. The Land development mechanism of HSK is shown in Figure 4.3.

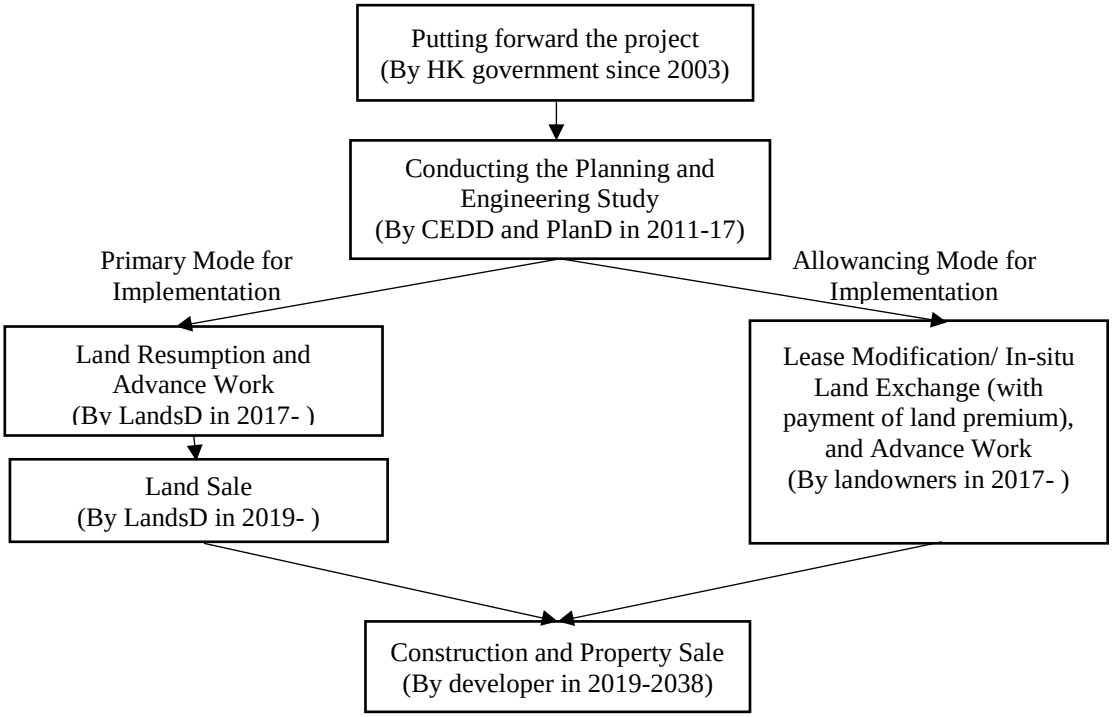


Figure 4.3 Land development process of HSK, HK

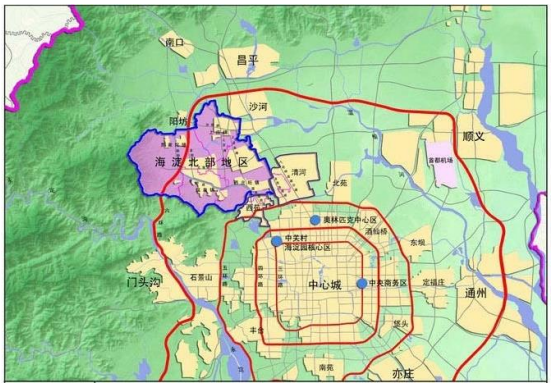
4.3.2 Haidian North in Beijing

[14] Hung Shui Kiu New Development Area Planning and Engineering Study – Investigation, April, 2017 http://www.hsknda.gov.hk/files/sotr/Executive%20Summary%20(EN).pdf

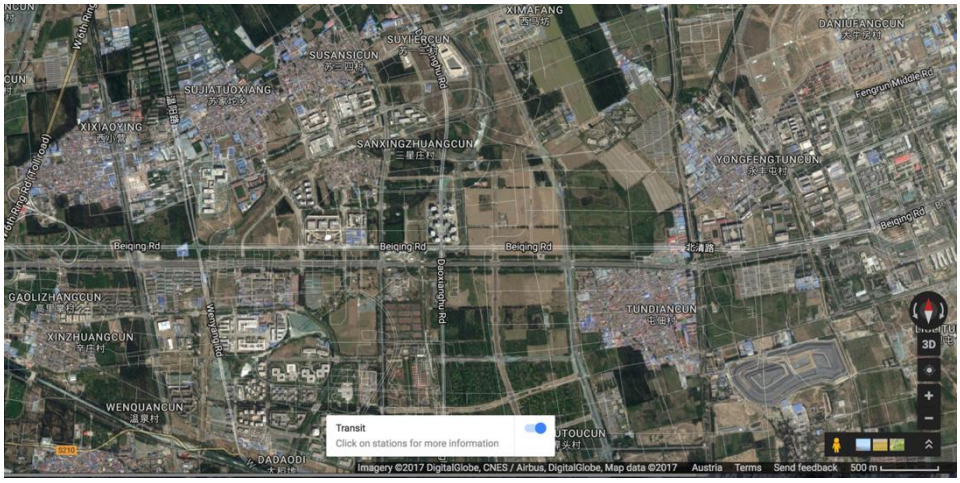
[15] Examination of Estimates of Expenditure 2017-18 Reply Serial No. DEVB(PL)152 http://www.landsd.gov.hk/en/legco/sfc_question_2017/DEVB(PL)152.pdf

Haidian North (HDN) development project, is located at the northwest of Beijing city centre. Haidian District is one of the four suburban districts (the other three are Chaoyang, Shijingshan, and Fengtai Districts) in Beijing. In the southern part of Haidian District, Zhongguancun is a very famous area for high-technology industry, which was developed in the last two decades. However, in its northern part, there are still some villages that show a typical land use pattern of urban-rural fringe. According to the government planning strategy in recent years, the northern part of Haidian with 226km^2 would be developed as an eco-technology development area, and the villages there would be reformed to provide land for industrial development, supplemented by commercial, residential and other land uses (Haidian government annual report of 2014-16).[16]

(a) The location of HDN in Beijing



(b) The scope of HDN



(c) The current land use situation of HDN (partly)

Figure 4.4 The location (a), scale (b) and current land use situation (c) of HDN

Source: (a) and (c) - Google Map; (b) – Beijing Municipal Institute of City Planning & Design[17]

[16]中关村国家自主创新示范区北部研发服务和高新技术产业聚集区(海淀北部地区)规划
[17] http://www.bjghy.com.cn/

Beijing Municipal Institute of City Planning & Design is an institution affiliated to Beijing Municipal Commission of Urban Planning and responsible for the plan of HDN. The data regarding the plan is collected from this institution. Since the scale of HDN is too large to be compared with the other three cases, a smaller scale of 2 blocks of 4-2 and 4-3 were selected. The plot located at the southeast of block 4-3 is in the Aerospace Town closed to the public. In the comparative study, this plot is excluded.

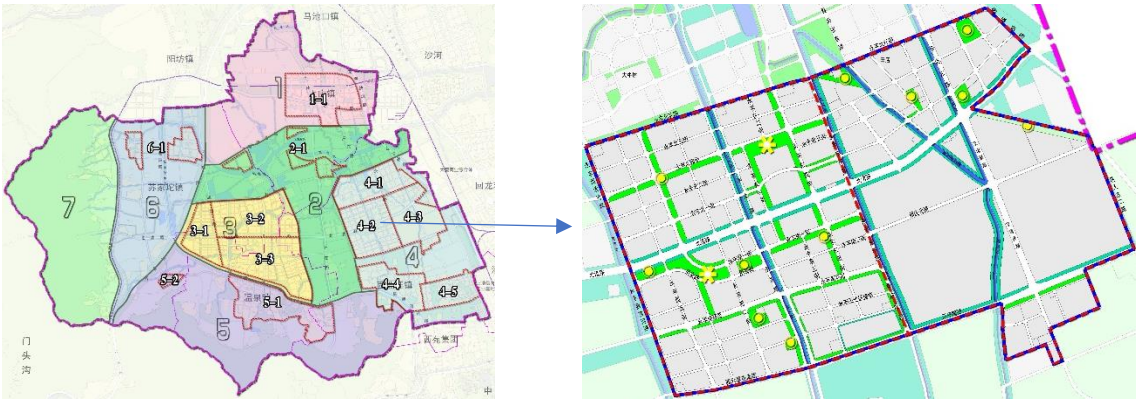


Figure 4.5 The Blocks in HDN plan (left) and the selected 4-2 & 4-3 Blocks (right)

In China, two types of public land ownership coexist, namely, collective ownership and state ownership. As regulated in the "Constitution", generally, land of urban districts belongs to the state, while rural and suburban land belongs to village collectives. According to "Land Management Law", the collectively-owned land, either farmland or built-up land, should be expropriated and converted to state ownership before it is converted to construction use, except those for township enterprise and farmers' rural housing (Wu et al., 2009). The process of urban growth starts from land acquisition, through which the development right is transferred from the collective owners to the state government, and then the construction company can use state-owned land for development after paying fees in accordance with the standards and approaches, which transfers the development right from the government to developers. After the developers obtain the development rights, they would build residential houses and sell them to house buyers, as the new-comers living in this area. The development mechanism of HDN is illustrated below.

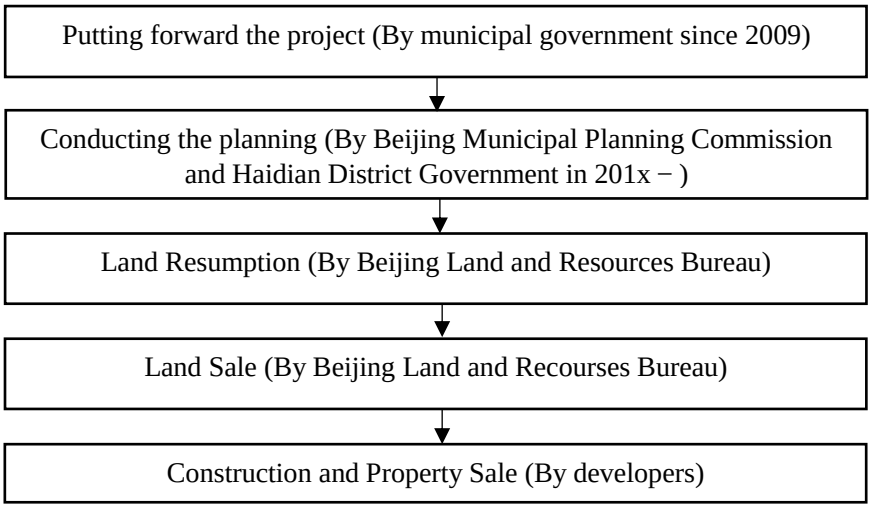


Figure 4.6 The land development process of HDN, Beijing

4.3.3 Seestadt in Vienna

The Seestadt project is the largest urban construction site proposed in Vienna's urban plan "STEP 2025." Seestadt is situated in Aspern, a northeast district of Vienna, the capital city in Austria. The land for the Seestadt development was formerly an airfield in urban fringe occupying 2.4 million m^2 of land. The Seestadt project aims to construct a new, multifunctional urban district for 20,000 residents, with 2.2 million m^2 gross floor space for apartments, offices, production and service businesses, science, research, education, shops, pubs and small businesses.

Figure 4.7 The location (a), scale (b) and current land use situation (c) of Seestadt in Vienna

(a). https://smartcity.wien.gv.at/site/wp-content/blogs.dir/3/files/2013/06/Stadtplan-wien.at_.jpg

(b). https://www.wien.gv.at/stadtentwicklung/projekte/aspern-seestadt/planungsprozess/masterplan.html

(c). Google Map

The land of Seestadt is publicly owned by the City of Vienna and the Federal Republic of Austria. These two public sectors are also the main shareholders of Wien 3420 Aspern Development AG, the company in charge of selling and leasing the building plots. The development mechanism of Seestadt is presented in Figure 4.8.

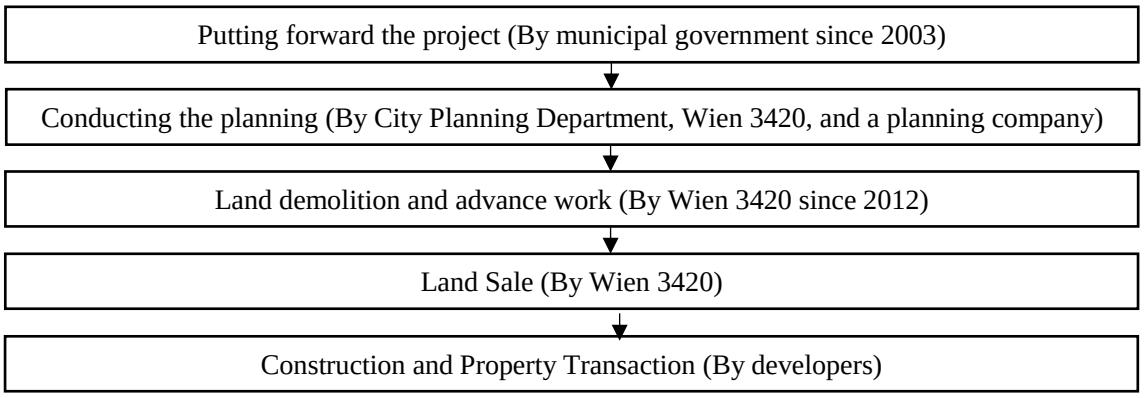


Figure 4.8 Land development mechanism of Seestadt, Vienna

4.3.4 Bushwick in NYC

The neighbourhood of Bushwick is in the northern part of borough of Brooklyn, the New York City. Different from the cases of HSK, HDN and Seedstadt, which are under developed, the Bushwick is a developed working-class community mainly with residence and community-based commerce. Confronting rapid population growth within the total area of 3.38 km^2, the Bushwick community plan is inspired by the increasing amount of out-of-context development in the neighbourhood. The Bushwick development, based on a proposed inclusive and comprehensive plan, aims to balance the desire to create and preserve affordable housing with the need to preserve Bushwick's character.[18]

Figure 4.9 The location (a), scale (b) and current land use situation (c) of Bushwick

Source: (a)and (c) - Google Map; (b) – the website of Bushwick Community Plan[19]

[18] http://www.bushwickcommunityplan.org/welcome/
[19] http://www.bushwickcommunityplan.org/

To deal with the request from Community Board 4 in 2013 to examine the possibility of creating a plan for the community, in 2014, Council members of Bushwick initiated a community-based planning process. The plan was to be implemented by stakeholders in different aspects to reach a development consensus. Since land is privately owned by landowners (most of them are development companies), landowners are responsible for the construction work according to the approved plan. The development mechanism of Bushwick is summarized in the follow diagram.

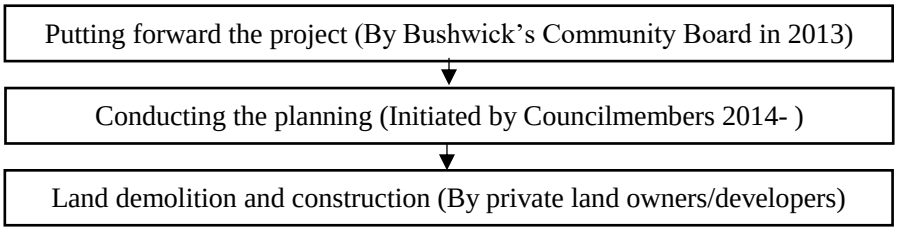


Figure 4.10 Suburban land development dynamics of Bushwick

4.3.5 Comparison of the development mechanism

UGS provision is a part of the land use plan in all development cases. In summary, land can be used either for conservation or for development. The two conflicting land utilizations represent different capital flows and wealth distributions. In land conservation, utilization control and conservation easement are normally used to restrict land development rights on the designated land. The former one is carried out through government's up-down planning without others' involvement, and the latter one is a transaction of property rights. In land development, land acquisition - which means the government acquires land from current land users for the development right - is an essential step for Beijing and Hong Kong. Although both the private and public landownerships exist in Vienna, the piece of land for Seestadt development is initially owned by the government. Land sale, from government to developer, is required for these three cases. However, in NYC the original land users/owners are the suppliers in the land market, and what the government can do is to rezone the use of land plots. The event of construction and house sale are the same in all four mechanisms. Collection of property tax from house buyers is regulated in HK, Vienna and NYC, but not in Beijing. In Beijing, there are taxes only on real estate transactions, but no recurring tax on house holdings, impacting on government revenue. For comparison, Figure 4.11 shows the processes in four land development and green space supply mechanisms, and the roles of agents.

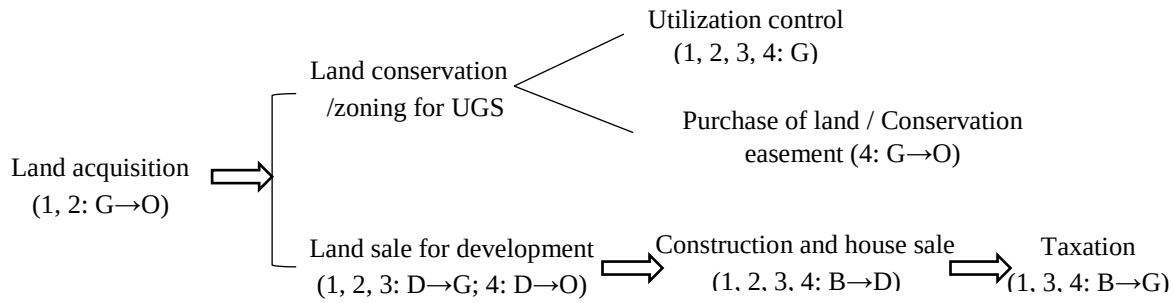


Figure 4.11 Processes and the roles of agents in land use of the four cases

Note: 1 for HSK, 2 for HDN, 3 for Seestadt, and 4 for Bushwick.

G, O, D, and B are short for government, original land user/owner, developer, and house buyer.

"→" implies the direction of capital flow, e.g. "1, 2: G→O" means in case of HSK and HDN, the governments pay original land users to acquire land.

The development process is complex, so the anti-growth authorities are affected by both socio-demographic and issue-related factors (J. Logan & Crowder, 1997). The difficulties in policy implementation varies between cities, and comparison of the urban development processes and mechanisms would help to understand the different difficulties in land conservation and open space provision. In the following sections, government attitudes to UGS zoning are analysed in terms of: a) the interest/wealth distribution in land development; and b) how governments' interests are affected by UGS provision.

4.4 Fiscal Concerns and Attitude Analysis

4.4.1 Government fiscal concerns in urban development

The share of municipal budgets for UGS provision is an essential expenditure upon public infrastructure and services, normally financed by unlocking the value of the land and allowing for the capture of a part of the increase in land value (Choumert, 2010; Mathur, 2013; Peterson, 2009). It is reasonable to assume that the increase in land value is beneficial to financing UGS. For example, urban development in big cities of the US contributes to the increase of urban trees in which richer communities have a larger budget on public forests (Zhu & Zhang, 2008). In China, land-related revenues and local government debts backed by land assets are the two major resources that local governments rely on to finance local public goods and stimulate the local economy (Zhang et al., 2016).

However, under the pressure of urbanization, it is observed that some local governments fail to adopt the planning standards of UGS provision (Haaland & Van Den Bosch, 2015). Focusing

on land and real estate development rather than concentrating on the externalities of market, some municipal authorities in Nepal do not have any specific plan, programmes and activities for urban greening (Lamichhane & Thapa, 2012). A negative relationship between revenue and UGS provision is revealed in China, indicating local governments' pursuit of maximizing land lease revenue that may even cause the loss of public green spaces (Chen & Hu, 2015). Although the state governments of the US emphasized the importance of land preservation, local governments resisted state intervention and were guided mainly by self-interest and peers' actions when deciding whether or not to change their ordinances for encouraging preservation (Loh, 2015).

So long as the local governments expect economic gains from urban development, there is a risk of sacrificing the provision of UGS for the supply of built-up lands. Facing this dilemma, the questions of how institutional arrangements influence government decision-making in land use planning and which kinds of institutional arrangements are beneficial to UGS provision, are worth exploring. Analyzing revenue and expenses facing government is a feasible method to help identify and address underlying barriers to UGS provision and identify sufficient incentives to change the behaviour of local actors (Buitelaar et al., 2011; Hotte et al., 2016). Accordingly, a model is established herewith to investigate the fiscal effects of different institutional mechanisms.

4.4.2 Principles of the agent-based model

Multi-agent analysis goes beyond the role of the individual and requires study of the different forms of organization and interactions among different organizational levels, applied from theorization about collective decision-making support (An, 2012; Bousquet & Le Page, 2004; Huang et al., 2014). It is used in this research to illustrate agents' incentives or barriers of land development or conservation, and as a tool for comparative study. From a government perspective, not only their governance but also their wealth involvements under different mechanisms play important roles in decision-making. To highlight government attributes and attitude to land development and UGS provision, an agent-based model is established to identify revenue changes in UGS supply and to compare the differences in four mechanisms.

Welfare produced in land use planning and development are distributed among involved groups, impacting their benefits and equality (Cheshire & Sheppard, 2002). The wealth created in land development, or change of wealth, equals to income minus expense (Formula 4.1).

$$\text{Wealth (W)} = \text{Income (I)} - \text{Expenses (E)} \quad (4.1)$$

Referring to the land development process, the incomes and expenses for different agents including original land owners/users, developers, governments, and new house buyers are classified in Table 4.2.

Table 4.2 The list of incomes and expenses in land development

Income (I)	Expense (E)
Compensation Payment as Income (I_{cp})	Compensation Payment as Expense (E_{cp})
House Sale Income (I_{hs})	Expense for Advance Work of Development (E_{aw})
Land Sale Income (I_{ls})	Expense for Planning and Study (E_{ps})
Tax Collection Income (I_{tc})	Land Sale Payment (E_{ls})
	Construction Costs (E_{cc})
	House Sale Payment (E_{hs})
	Tax Payment for Property (E_{tp})

According to development mechanisms summarised in Figure 4.11, agents in the development of HSK, HDN, Bushwick (B), and Seestadt (S) earn or spend money in different approaches, leading to the changes of wealth. The formulas to calculate the Income (I), Expense (E), or Wealth (W) under the four mechanisms are established. In formula (4.2) to (4.10) below, the subscript represents the different development mechanism, e.g. I_{HSK} means income in case of HSK; and σ is the standard error implying other unforeseen incomes or expenses in development.

Income of original land owners/users:

$$I_{HSK} = I_{HDN} = I_{cp} + \sigma \quad (4.2)$$

$$I_B = I_S = I_{ls} + \sigma \quad (4.3)$$

Wealth of developers:

$$W_{HSK} = W_{HDN} = W_S = W_B = I_{hs} - (E_{ls} + E_{cc}) + \sigma \quad (4.4)$$

Wealth of government:

$$W_{HSK} = (I_{ls} + I_{tc}) - (E_{cp} + E_{aw} + E_{ps}) + \sigma \quad (4.5)$$

$$W_{HDN} = I_{ls} - (E_{cp} + E_{aw} + E_{ps}) + \sigma \quad (4.6)$$

$$W_S = (I_{ls} + I_{tc}) - (E_{aw} + E_{ps}) + \sigma \quad (4.7)$$

$$W_B = I_{tc} - (E_{aw} + E_{ps}) + \sigma \quad (4.8)$$

Expense of house buyers:

$$E_{HSK} = E_B = E_S = E_{hs} + E_{tp} + \sigma \quad (4.9)$$

$$E_{HDN} = E_{hs} + \sigma \quad (4.10)$$

As indicated by the formulas, mechanisms have impacts on agents' interests in term of the approaches of income and expenses. The wealth of governments gained in land development are considerably varied, with every mechanism involving different relationship of interest (Formulas 4.5 to 4.8). The income of original land owners/users is sourced either from compensation (Formula 4.2) or land sale (Formula 4.3). The wealth of developers is created in the same approach under four mechanisms (formula 4.4). Except for HDN where house buyers are not obligated to pay property tax (Formula 4.10), expenses of other house buyers contain payment both for property purchasing and property taxation (Formula 4.9). Theoretically, the formulas established in this section identified the differences of wealth gained by agents in according to different land development mechanisms.

When providing UGS, the land will be conserved rather than developed, and the wealth/revenue government could obtain from land development will be changed correspondingly. To quantify the changes of revenue in UGS supply, scenario simulations were conducted to investigate the relationship between green coverage rate (R_g) and Revenue under the four land development mechanisms. Government is the human agent gaining revenue, while the piece of land is the physical agent representing the environment. At the beginning, the model is initialized with the whole development pattern and no UGS is provided ($R_g = 0\%$). The total land area, which is the sum of the area of land for development and the area of land for UGS, is set as a unit area ($1km^2$). In the simulation, R_g is the independent variable, which equals to the land area for UGS divided by the total land area, while Revenue is the dependent variable which will be changed as R_g increases. The dynamic changes of Revenue under four mechanisms are calculated as $W_{HSK,}$ W_{HDN}, W_S, and W_B based on Formulas 4.5, 4.6, 4.7 and 4.8 accordingly. Two scenarios with PR=1 and PR=3 are designated. To exclude other factors

which may intervene the comparison of development mechanisms, only the data of HSK will be used in the simulation. The model will demonstrate the relationships between R_g and Net Revenue and the differences in the four mechanisms as well as in the two scenarios.

4.4.3 Data collection of the selected case

Since real market data of HK contains all variables for calculating income and expenses (in Table 4.2), the agent-based model of HK land development and conservation was chosen as the basis and the values of the variables are collected based on the cases of HSK. By interchanging and recombining the mechanisms of the four cases, comparative study will be conducted through agent-based modelling, which is to illustrate wealth distribution of land development, showing how much government, original land users/owners, developer, and new house buyers benefit or loss in the process of land development and UGS provision. Variables of original population (OP), compensation payment (CP), land resumption price (LRP), land sale price (LSP), house price (HP), cost of advance work (AW), plot ratio (PR), tax ratio (TR), annual rent (AR), discount rate (r) and land use year (n) were considered in this model.

In HK, future new land development projects were mainly concentrated in the district of the New Territories. CP was calculated according to the compensation standard in HK new development areas, located in the New Territories, which was HK$600,000 cash allowance per person the for each affected original resident maximally as a special ex-gratia cash allowance, and the population density of HK in 2014 which was 6,690 people/km^2, sourced from the Census and Statistic Department[20]. The average LSP and LRP per floor area was calculated based on the 18 land sale cases and 9 land resumption cases in the New Territories published by the Hong Kong Lands Department in year 2014-15[21], which were HK$47,560/m^2 and HK$3,120/m^2. Average House Price (HP) of private premises in the type 70-99.9 m^2 was HK$89,607/m^2 in the New Territories, and rents of these premises was HK$227/m^2 per month, according to the Hong Kong Annual Digest of Statistics 2015 edition[22]. Based on a rough estimate, the estimated total cost of site formation and engineering infrastructure for the HSK NDA is approximately HK$50 billion in September 2015 prices.[23] Regarding the development area of 4.42km^2, the average cost of advance work (AW) is set as HK$11,312/m^2. Rates are taxes levied on properties, so the Tax Rate (TR) in HK was 5%, established by The Rating and

[20] Census and Statistics Department. http://www.censtatd.gov.hk/hkstat/sub/so20.jsp
[21] Lands Department. www.landsd.gov.hk/en/landsale/records.htm
[22] Census and Statistics Department. www.statistics.gov.hk/pub/B10100032015AN15B0100.pdf
[23] Hung Shui Kiu New Development Area Planning and Engineering Study – Investigation, April, 2017. http://www.hsknda.gov.hk/files/sotr/Executive%20Summary%20(EN).pdf

Valuation Department, charged at a percentage of the estimated annual rental value of a property at a designated valuation situation [24]. Discount rate (r) is assigned as 3.2%, which is the average composite interest rate in January-July 2015 published by Hong Kong Monetary Authority[25]. To avoid the negative values of variables, the parameter of plot ratio (PR), representing the density of development, is added in the model to adjust the value of revenue in the condition of the same mechanism. For the value of variables and equations in the model, see Table 4.3.

Table 4.3 The values of the variables and the formulae in the model

Variable	Value	Variable	Value
Land Sale Price (LSP)	47,560 HKD/m^2	House price (HP)	89,607 HKD/m^2
Land Resumption Price (LRP)	3,120 HKD/m^2	Annual rent (AR)	2724 HKD/m^2
Compensation payment (CP)	40140 HKD/m^2	Tax rate (TR)	5% (property annual rent)
Formulas (Unit of the variables: HK$/$m^2$)			
Land sale = LSP * PR.			
Land resumption = LRP.			
Compensation = CP * OP.			
Land acquisition = LRP + CP.			
House sale = HP * PR.			
Tax collection = AR * PR * TA * [1/ r – 1 / [r * (1+r) ^{n}]], where r=3.2%.			

The related incomes and expenses in case of HSK are enumerated in Table below.

Table 4.4 The value of the incomes and expenses in case of HSK (HK$/$m^2$)

Income (I)	plot ratio=1	plot ratio=3	Expense (E)	plot ratio=1	plot ratio=3
I_{cp}	43260	43260	E_{cp}	43260	43260
I_{hs}	89607	268821	E_{aw}	11312	11312
I_{ls}	47560	142680	E_{ps}		
I_{tc}	3371	10113	E_{ls}	47560	142680
			E_{cc}	39115	117345
			E_{hs}	89607	268821
			E_{tp}	3371	10113

4.4.4 Net revenue changes in the four cases

[24] Rating and Valuation Department. www.rvd.gov.hk/en/public_services/rates.html
[25] Hong Kong Monetary Authority. www.hkma.gov.hk/eng/market-data-and-statistics/

The net revenues of government are calculated based on formula of wealth gained by government (4-5 to 4-8) and the values of incomes and expenses. The results of the four cases are shown in the following Figure.

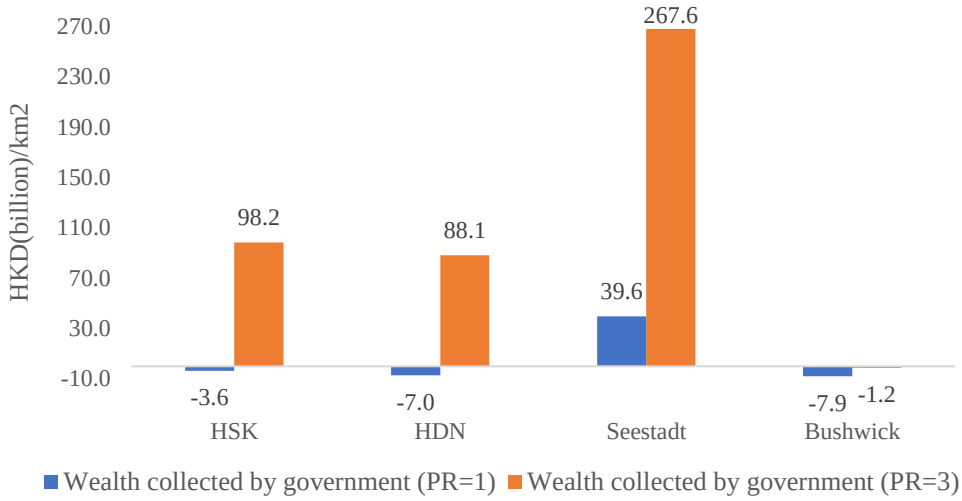
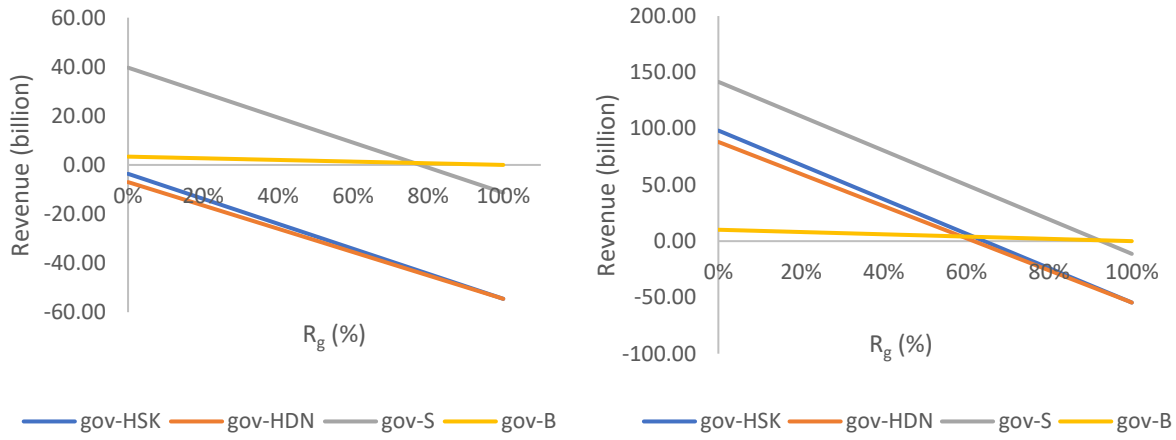


Figure 4.12 Comparison of wealth gained by government under the four development mechanisms

Accordingly, the revenue gained by government considerably differs under the four development mechanisms. In general, the mechanism of Seestadt creates the most revenue with HK$267.6 billion and HK$39.6 billion in the development of low and high density. Under the mechanism of HSK and HDN, revenues (HK$98.2 and HK$88.1 billion) are generated in high-density development; however, in case of low density, government will lose rather than gaining benefit from the development. The worst situation shows in Bushwick mechanism, as the values of wealth are negative in both development scenarios. Considering the obligation in conducting planning and advance work, it is difficult for government to balance between income and expenditure if only depends on the revenue generated from the development project.

The analysis of wealth distribution demonstrates how the wealth generated from land development is distributed among agents, how much government could gain from the development, and what are the differences of the amount of revenue in the four designated mechanisms. Land development and land conservation are conflicted regarding the restriction of land availability. Facing the two alternatives of development or conservation, revenue gained from the piece of land will be a concern of government when making land use decisions. The subsequent question is if a percentage of land was designated for UGS rather than built-up land, how would it influence wealth distribution? In the next section, the impact of land development and UGS supply mechanism on governments' revenue as well as on their attitude to UGS supply will be studied through agent-based modelling.

Along with the supply of UGS, the area of land for development decreases, so does governments' revenues. Figure 4.13 illustrates how the revenues change with R_g. The results of two scenarios where PR=1 and PR=3 are showed in Figure 4.13(a) and Figure 4.13(b) respectively. For each scenario, revenues generated under four mechanisms are compared.



(a) PR=1 **(b) PR=3**

Figure 4.13 Comparison of the relationship between R_g and the Revenue of government

The results suggest in both scenarios and all mechanisms, the Revenues decrease with the increase of R_g. In Figure 4.13(a) where PR=1, the government of Seestadt (grey line) gains the most revenue, while the governments of HDN (orange line) and HSK (blue line) suffer economic losses. Despite the maximum revenue within a certain range of R_g, the government of Seestadt changes from economic benefit to economic loss when Rg is larger than 77%. In contrast to obvious changes in the cases of Seestadt, HDN and HSK, revenues gained by Bushwick government (yellow line) are not only invariably positive but also relatively stable in both scenarios. Referring to Figure 4.13(b) where PR=3, the revenue of Seestadt is almost tripled compared with Figure 4.13(a) at the beginning, and government of HDN and HSK also gain economic benefit from the development. However, as R_g increases, revenues of HDN, HSK and Seestadt turn to negative values when R_g is larger than 61%, 64% and 92%.

4.4.5 Comparison of government attitudes

The changes in revenue reflect the performance of the mechanism. Regarding earning capacity, profitability and stability, the four mechanisms are compared based on the different changes of revenue. More information together with analysis is listed in Table 4.5.

Table 4.5 Comparison of the UGS supply mechanisms based on the changes in development revenue

Evaluation aspect	Definition	Evaluation criteria	Performance comparison*	Main determinant in revenue change
Earning capacity	The general ability of government to gain benefit.	The larger revenue, the better the performance is.	Seestadt >> HSK > HDN > Bushwick	The source of income
Profitability	The general ability of government to avoid economic loss and gain profit.	The more probable to get profit, the better the performance is.	Seestadt > HSK > HDN > Bushwick	The amount of expense
Stability	The general ability of government to keep revenue unaffected by UGS supply.	The less sensitive to R_g change (the smaller the absolute value of the slope), the better the performance is.	Bushwick >> HDN > HSK ≈ Seestadt	The association of revenue with market

** Notes: >> means "is much better than"; > means "is better than"; ≈ means "is almost the same as".*

According to the analysis in Table 4.5, earning capacity, profitability and stability of government is related to the source of income, the amount of expense, and the association with market. The best performances of Seestadt in earning capacity and profitability are attributed to its dual sources of income (land sale and taxation) and limited expenses (advance work only). Since its large amount of revenue is closely related to the real estate market, the stability of Seestadt is relatively low, which is similar with HSK. The income of Bushwick is merely dependent on taxation, implying the weakness in earning capacity and profitability as well as the strong stability of maintaining revenue. Both HSK and HDN are always ranked in the middle regarding the three evaluation aspects. To purchase the development rights of land, governments must pay for existing land owners/users in HSK and HDN, therefore they are vulnerable to suffer economic loss. With dual sources of income, HSK performs better in earning capacity and profitability than HDN where land sale is the sole source of income.

Due to different attributes, governments may have different answers to the questions of whether to encourage UGS provision or not, whether to support it financially or not, how much UGS to supply in a development project, etc. To interpret the effect of land development mechanism on governments' attitude to UGS supply, the relationship between the attributes and attitudes is set out in Table 4.6.

Table 4.6 Relationship between financial attribute in development and government attitudes

Attribute	Government Attitude to UGS Supply (in terms of revenue)	
	Feature of the attribute	Mark*
High earning capacity	Encouraging to develop land for economic benefit	+/-

Low earning capacity	Unconcerned about whether to expand the development or not	+/-
High profitability	Bold to provide UGS with little to worry about in term of economic loss	+
Low profitability	Conscious in increasing UGS regarding the potential economic loss	-
High stability	Unconcerned about whether to provide UGS or not	+/-
Low stability	Reluctant to provide UGS regarding the reduction of revenue	-

*Notes: Positive (+), Negative (-), Mutual (+/-).

The mechanisms are compared based on government attitudes in the three aspects.

Table 4.7 Comparison of government attitudes under four mechanisms

Mechanism	Earning capacity	Profitability	Stability	Government Attitude (in terms of revenue) *	
HSK and HDN	High	Low	Low	a. Encouraging to develop land for economic benefit b. Conscious in increasing UGS supply regarding the potential economic loss c. Reluctant to provide UGS regarding the reduction of revenue	-
Bushwick	Low	Low	High	a. Unconcerned about whether to expand the development or not b. Conscious in increasing UGS regarding the potential economic loss c. Unconcerned about whether to provide UGS or not	-
Seestadt	High	High	Low	a. Encouraging to develop land for economic benefit b. Bold to provide UGS with little to worry about in term of economic loss c. Reluctant to provide UGS regarding the reduction of revenue	+/-

*Notes: Based on features of a, b, and c, the overall attitude of Positive (+), Negative (-) or Mutual (+/-) is identified by summing up the marks of three features.

Referring to attitudes, one might expect that the stakeholders who benefit the least from the development would be the strongest barriers to UGS provision, in case their benefit would be influenced: because they are most likely to face financial losses if some land could not be sold. In contrast, the more profit the stakeholder obtained, the more likely they would support UGS provision. It is suggested governments in China have more ability than NYC government to gain benefits from land development, as well as to support land conservation with land revenue.

4.5 Results and Comparison of Institutional Mechanisms

4.5.1 The effect of institutional factors

As the consequences of urban growth, natural or not well-developed land in suburban and rural area were replaced by urban built-up land for residential, industrial, commercial and other uses. The competition between UGS provision and other land uses is highly influenced by government, who is both the important operator of the urban growth machine and simultaneously the supplier of public green spaces. Institutional mechanism of urban development does impact on the allocation of land recourses. The results of comparison are shown in table below.

Table 4.8 The comparison of financial attribute and UGS outcome in the four cases

Case	HSK	HSN	Seestadt	Bushwick
Attribute: Earn Capacity	2nd	3rd	1st	4th
Attribute: Profitability	2nd	3rd	1st	4th
Attribute: Stability	3rd	2nd	4th	1st
Performance of UGS Pattern	2nd	3rd	1st	4th

The attribute of government revenue is related to the institutional characteristics of land development mechanism. Land ownership, regarding both the initial status as well as the arrangement in the process, is the most complex influential factor in land development mechanisms. It is a major determinant of the attributes of capacity and profitability. Under public land ownership, governments of gained the largest proportion of benefit than others, because they originally owned the land and could sell the land directly without input. In China, both mainland and HK, due to its semi-public land ownership system, land acquisition with corresponding compensation was required to obtain the property rights from original collective land owners/users before selling the land on the market. Although they could gain higher wealth proportion than USA in some circumstances (Figure 4.13b), the uncertainty in compensation cost and other factors such as low density might make China's government lose rather than gain benefit from land development. They are capable to support land conservation with large wealth occupation in land development. However due to a higher percentage of revenue loss, they became more reluctant to provision UGS than governments in either the public or private market. Owing to the lack of sources of property tax, local governments in mainland have relied more on land acquisition, which produces land income to local governments used for fuelling urban development and financing infrastructure provision (Ding, 2007). Under private land ownership, local governments in the USA place more reliance on property tax, which is a relatively stable source of fiscal revenue. Apart from its economic effect, the availability of land for conservation and the implementation of green urban designs were also related to land ownership.

The condition of initial ownership determines which kinds of instruments can be implemented. Once local governments own the land resources either inherently (Seestadt) or through acquisition (HSK and HDN), basic planning and regulatory tools of comprehensive plans, zoning ordinances, etc. are given preference to manage urban development, which is a traditional approach in developed countries such as the US and still widely used in developing countries such as China (Bengston et al., 2004; Zhou & Wang, 2011). However, as more land being occupied by private or collective owners as well as more competitiveness in urban land market, it becomes increasingly difficult for municipals to commit regulation or acquisition, resulted in the rise of incentive-based strategies (Bushwick). According to the interview, a new park in Bushwick will be built in exchange for increased density when private landowner conducting new development. The government do not need to buy the land, because it was an exchange for a higher density. Although this kind of market-based instrument performs better financial flexibility, it requires superior institutional capacity to implement than the costly instrument such as purchasing of land or providing conservation subsidies.

The ranks of stability are in the reverse order of other two attributes. Local governments' reliance on property tax was related to the attribute of stability. Although its impact of property tax is less than land ownership through comparison of the four cases, it is primarily verified to be positive to land conservation. In the USA, instead of individual income taxed, sales taxes, specific excise taxes, fees and charges, the dominant source that local government relied on is the property tax, and such relative stable reliance was regarded as an advantage for local government in case of unstable economic environment (Alm et al., 2011).

4.5.2 The enforcement of UGS planning standards

The standard for planning is an important institutional component in urban development. Based on the UGS layouts of the four cases, the enforcement of the UGS standards can be evaluated. It is suggested the standards are reached in the cases of HSK and Seestadt, while HDN and Bushwick fail to meet the standard. According to the standard in HK (Table 3.3), with 218,000 population, the area of HSK should provide a minimum of 43.6 ha open space. Referring to the recommended outline development plan of HSK, the total area of open space is 66 ha, consisting of 16 ha of RO, 27 ha of DO, and 23 ha of LO. Both the apportioned and overall standards for the provision of open space are satisfied. Moving to HDN, the areas of park land and green buffer in block 4-2 and 4-3 are about 68h.a. and 55h.a. respectively. The population excluding Aerospace Town is about 66 thousand, leading to the average park land area per capita of 10.4m^2, below the mentioned standard of 15~18 m^2 per capita. It is proposed in the

HDN plan to upgrade the function of green buffer through channel improvement so that people can use more UGS. According to the "Green and open space standard for Vienna" (Table 3.4) and the planned population, the area of green and open space in Seestadt should be 440,000m^2; however, with 681,790m^2 of land conserved for public spaces comprising greenbelts, parks, bodies of water, etc., the concept of a green city was emphasized in the Seestadt master plan. In Bushwick, the interviewee from Parks Department pointed out that the UGS in Bushwick did not meet the requirement of accessibility. By integrating these findings with planning performance and quality of standard (Section 3.2.2), the impact of planning standard on UGS performance could be discussed.

Table 4.9 The comparison of planning standard and UGS outcome in the four cases

Case	HSK in HK	HDN in Beijing	Seestadt in Vienna	Bushwick in NYC
Quality of the standard	2nd	3rd	1st	4th
Enforcement of the standard	2nd	3rd	1st	4th
Performance of the UGS planning outcome	2nd	3rd	1st	4th

According to the table above, the performance of UGS planning outcome is highly consistent with the quality of the planning standard as well as the enforcement of the standard regarding UGS. This highlights the importance of planning standard on shaping the planning outcome. High-quality standard (Seestadt) regulates the catchment area, size of UGS, and relatively larger area of UGS provision per capital in different scales. Comparing the two tables of Table 4.8 and Table 4.9, it suggests the enforcement of the standard is related to the attributes such as earn capacity and profitability under particular institutional arrangements. It indicates both the standard itself and the institutional mechanism associated with the implementation of the standard are influential to the performance of planning outcome.

4.5.3 Approaches for improving UGS provision in institutional perspective

Based on the results revealed in this Chapter, a few approaches are proposed in institutional perspective to improve UGS provision, regarding land ownership, instrument, taxation, and planning standard. For countries (most developing counties and some developed countries) which are under public land ownership or are capable to gain public land ownership through land acquisition or land purchasing, are highly recommended to take this advantage to assign initial public ownership before developing the land, using greening regulation and strategies to improve UGS provision in urban development. While financial revenue could be collected

through other sources, local governments' sensitivity to land conservation in semi-public market could be reduced by modifying the land development mechanism, an approach of which is to shift their roles from land traders to more concentrated land managers. It is suggested that the original and future land users would be able to negotiate with each other to make land use decisions. In this case, government would no longer be involved in land resumption financially, and provide considerably decreased inputs to the land development process. Instead, they could focus more on land use control as well as market monitoring to guarantee the green spaces supply. This kind of land use mechanism appeared in some cities in China. For example, lease modification was proposed as an alternative way of land resumption in HK suburban development. In case of the positive effect of property taxation on financial stability, it is recommended that the tax system should be adjusted to improve the institutional mechanism regarding the stable government revenue to support UGS provision. Further considerations of applying these approaches are discussed and recommended in Chapter 7.

CHAPTER 5 PARTICIPATION MECHANISM AND SOCIAL UTILITY OF UGS PROVISION

5.1 Summary of Chapter 5

It is important to advance the understanding of the mechanism of public participation, by answering the questions of what is the connection between participation process and outcome (Christensen, 2015), and to what extent the interests of public could be considered. This Chapter explores the relationship between the planning participation mechanism and social utility, through comparing the effectiveness of public participation in different cases, based on public satisfaction/utility regarding UGS arrangements in land use planning. To conduct this analysis, the objective process of participatory planning will be illustrated while the effectiveness of public participation will be evaluated and connected to the objective process. The framework of this Chapter is diagrammed in Figure 5.1.

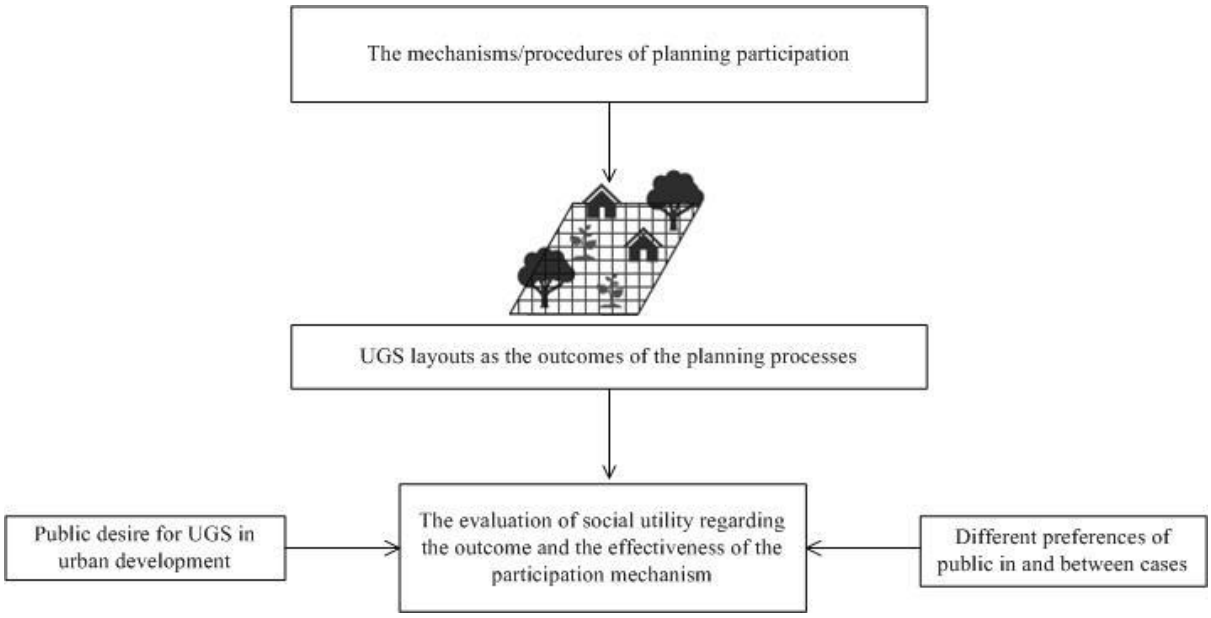


Figure 5.1 The diagram of the relationship between planning participation mechanism and UGS provision

Note: The arrows with solid line "→" indicate the research flow, explained in this chapter in terms of social utility

This Chapter starts with the description of the participation mechanisms of the four cases (Section 5.2). The public desires in urban development and land use planning, especially their perceptions to UGS are investigated through analysis of questionnaire surveys. The results are compared in Section 5.3. Afterwards, Section 5.4 evaluates the social utilities of the UGS

provision, by measuring the matching degree of public desire and landscape planning and the impact of participation mechanisms. Results and findings are illustrated and briefly discussed in the fifth section.

5.2 Planning Participation Mechanisms

5.2.1 Hung Shui Kiu in HK

The development project of Hung Shui Kiu (HSK) New Development Area (NDA) is located in the north west New Territory, HK. The study task flow of making the Outline Development Plan (ODP) and Layout Plans as extracted from the official website[26] and adjusted, shown in Figure 5.2.

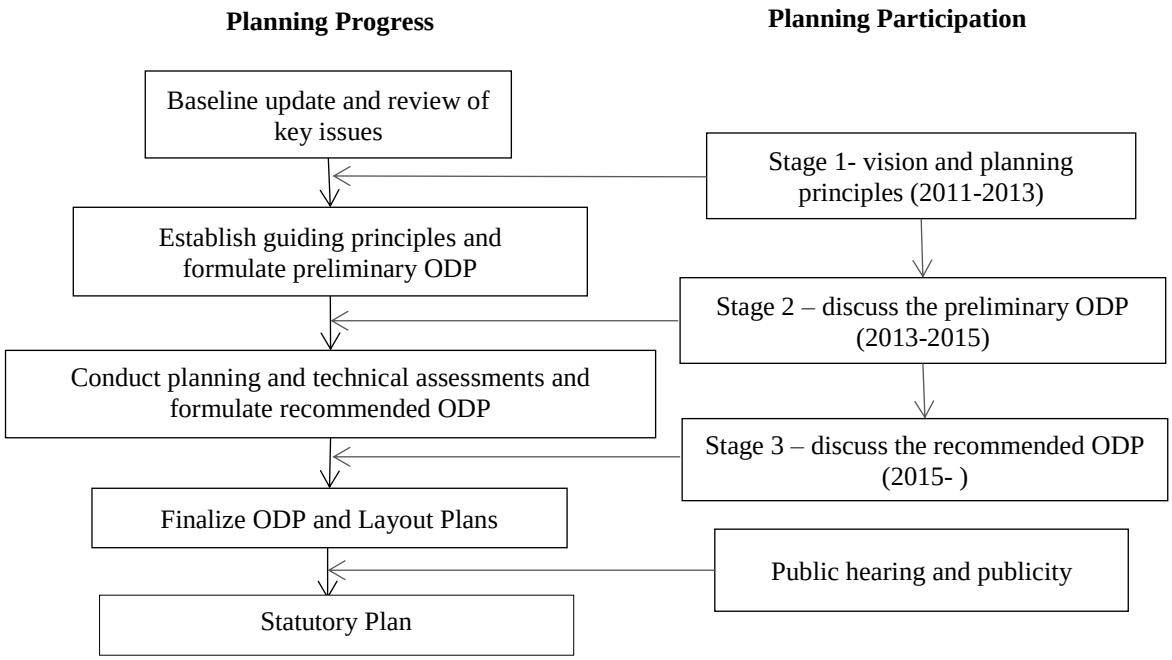


Figure 5.2 Planning process and participation mechanism of HSK, HK

The Community Engagement Programme consists of 3 stages, with various approaches provided to encourage public participation. Diversified activities such as public forums, briefings, meetings, etc. were organized by the government to involve the stakeholders of HSK development in the Study. The main approaches of public participation conducted are presented in Table 5.1.

Table 5.1 The main approaches of public participation in HSK planning

Approach	Description	Targeted stakeholders / Participants

[26] Civil Engineering and Development Department and Planning Department, Hung Shui Kiu New Development Area Planning and Engineering Study. Available at http://www.hsknda.gov.hk/index.html (Accessed: 10 May 2016)

Consultation Digest	Digest informing the details of the proposed ODP and inviting views from the public	Relevant stakeholders and residents within and in the vicinity of the NDA
Roving Exhibition	Exhibition boards and video on the ODP were displayed in public areas to invite the public to make comments	The public
Study Website	A platform to disseminate information to and receive comments from the public	The public
Public Forum	Public forums were held at the Auditorium of Yuen Long Theatre	The public
Briefing Sessions	Briefings were held with statutory and advisory committees and local community representatives	Panel on Development of Legislative Council, Town Planning Board, Advisory Council on the Environment, Yuen Long and Tuen Mun District Councils, Heung Yee Kuk, and Ping Shan, Ha Tsuen and Tuen Mun Rural Committees.
Consultation Meetings	Meetings were held with stakeholders	Professional bodies, Green Groups, affected villagers, local concern groups, port back-up and open storage operators, Hong Kong Logistics Council, Hong Kong Council for Testing and Certification, local industry operators.

The comments received in Stage 2 Community Engagement have formed the basis for formulating the RODP, the Preliminary LPs, the implementation mechanism and programme for the NDA.

Figure 5.3 Photo of public forum of HSK development study (taken by the author in Aug. 2015)

5.2.2 Haidian North in Beijing

In case of HDN planning, the Beijing Municipal Planning Commission is responsible for the formulation of the Detailed Regulatory Plan (DRP). According to the "Beijing Detailed Regulatory Plan Compilation, Approval and Management Measures", when the DRP draft is completed, it should be announced to the public by the responsible authority in accordance with the law, through discussion meeting, hearing or other way to solicit opinions of the experts as well as the general public, and the duration of announcement shall not be less than 30 days. The approaches of public participation are investigation and publicity. Since there is no website for the project, the information for publicity was posted on the official website of the Haidian Branch of Beijing Municipal Planning Commission.

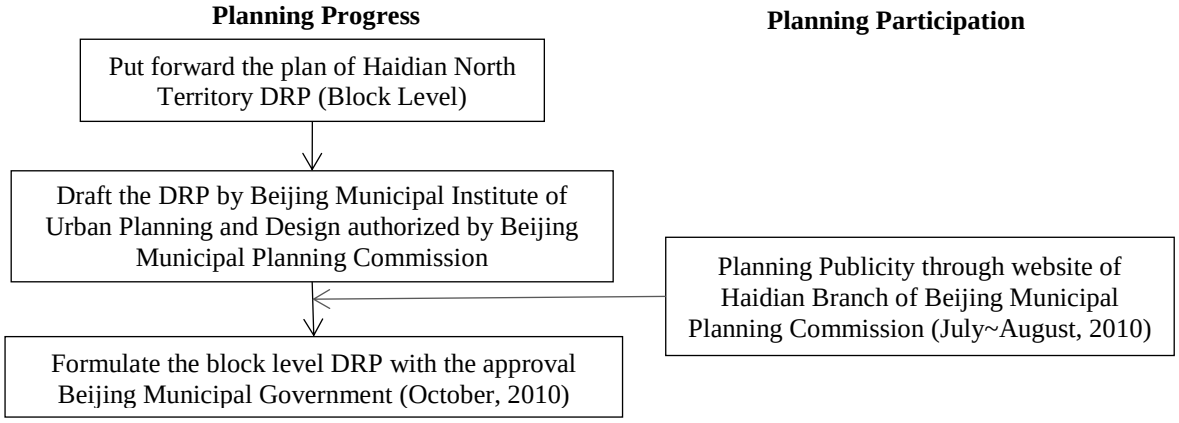
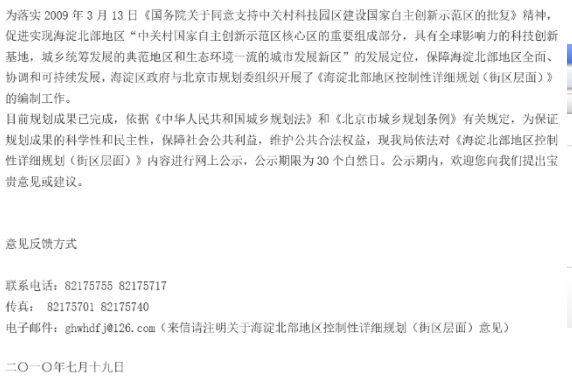


Figure 5.4 Planning participation mechanism of HDN, Beijing

After the publicity, the information of the DRP was removed from the website, even though it is regulated in "Beijing Detailed Regulatory Plan Compilation, Approval and Management Measures" that the approved DRP should be published. If members of the public want to know the DRP afterwards, they are required to apply for information disclosure by email, mail, phone call, or on-site consultancy. Based on the block-level DRP, the plot-level DRPs of the development territory will be formulated with the same public participation process.


为落实 2009 年 3 月 13 日《国务院关于同意支持中关村科技园区建设国家自主创新示范区的批复》精神，促进实现海淀北部地区“中关村国家自主创新示范区核心区的重要组成部分，具有全球影响力的科技创新基地，城乡统筹发展的典范地区和生态环境一流的城市发展新区”的发展定位，保障海淀北部地区全面、协调和可持续发展，海淀区政府与北京市规划委组织开展了《海淀北部地区控制性详细规划（街区层面）》的编制工作。

目前规划成果已完成，依据《中华人民共和国城乡规划法》和《北京市城乡规划条例》有关规定，为保证规划成果的科学性和民主性，保障社会公共利益，维护公共合法权益，现我局依法对《海淀北部地区控制性详细规划（街区层面）》内容进行网上公示，公示期限为 30 个自然日。公示期内，欢迎您向我们提出宝贵意见或建议。

意见反馈方式

联系电话：82175755 82175717
传真： 82175701 82175740
电子邮件：ghwhdfj@126.com（来信请注明关于海淀北部地区控制性详细规划（街区层面）意见）

二〇一〇年七月十九日

Figure 5.5 The screenshot of publicity information in the website of the planning commission *(in Chinese)*

5.2.3 Seestadt in Vienna

Consisting of members of the Planning Department and the land owners, the project team is responsible for making the Seestadt Masterplan in 2003~2007. The public was involved into the planning at an early stage and all through the planning process. Even before the formulation of the Masterplan, the residents of the airfield area were given the opportunity to cooperate through questionnaire by mail, expressing their requirements for and concerns in the future development. Exhibitions, public forums and focus group meetings were organized to collect public opinions on the first draft and the later version of the Masterplan. Some citizens were nominated as "Experts on the ground", which means they could participate in the whole process of plan formulation and they were given seats to vote in the planning evaluation commission. The planning participation mechanism of Seestadt, Vienna is illustrated in the figure below.

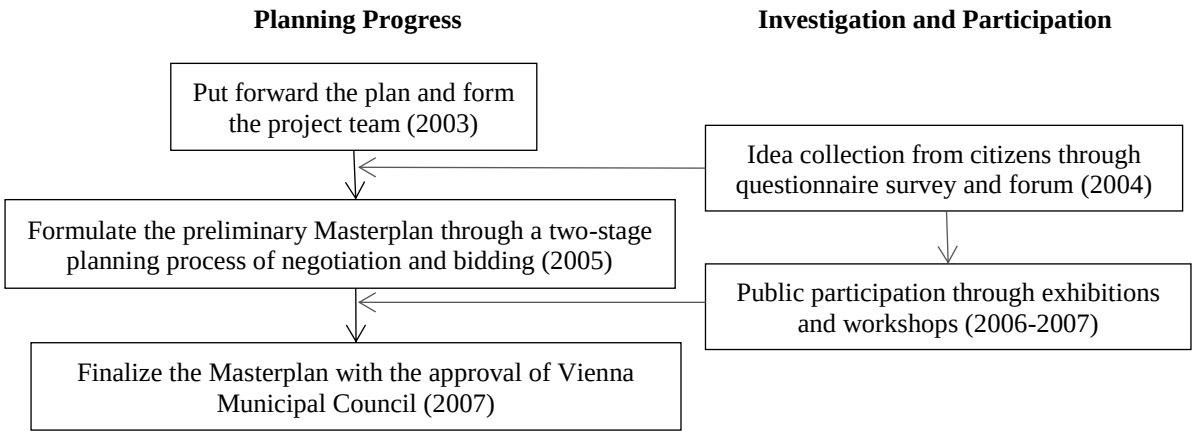


Figure 5.6 Planning participation mechanism of Seestadt, Vienna

Referring to the two-stage planning bidding process, ten planning teams were selected after the briefing and negotiation in a first stage. Afterwards, the selected teams developed urban design schemes for competition, and the evaluation committee of 15 international experts made the decision of which team to choose based on their schemes. Finally, the planning team of "Tovatt Architects & Planners" (a Swedish designing company) and the "N + Objektmanagement GmbH" (a German development company) was commissioned to formulate the Masterplan of Seestadt development. Before and after the scheme competition, different approaches of public participation were conducted (Table 5.2).

Table 5.2 The main approaches of public participation in Seestadt planning

Approach	Description	Participants

Questionnaire survey	About 6,000 questionnaires were posted to households in the vicinity of the Aspern airfield in March 2004. The response rate is about 5%.	Respondents of the questionnaires
Public forum and focus group meeting	A public event was held on 24 April 2004, to introduce the plan, present the results of the questionnaire survey, and discuss about the future based on "Idea Collection with Citizens" in groups. "Experts on the ground" were nominated.	Approximately 200 participants, including representatives of the surrounding settlers, associations and citizen attended.
Exhibition and workshop	The first draft of the Masterplan was presented in May 2006 in the "Haus der Begegnung" (English = Meeting House) of Donaustadt, followed by a workshop for the public to get information from architects and the project team. The basically completed Masterplan was presented to the public through exhibitions in 2007 in the "Haus der Begegnung", Donaustadt and "Wiener Planungswerkstatt" next to the City Hall.	The public. Around 600 people joined the workshop.
Project Website	Referring to the development of the site, the website was announced as a platform to disseminate information to and receive comments from the public.	The public

5.2.4 Bushwick in NYC

The neighbourhood of Bushwick is in the northern part of borough of Brooklyn, the New York City. The first round of public outreach included four 'visioning' town hall meetings with over 200 participants, five zoning workshops, and three issue-specific meetings. This process identified several priority issue areas, including: affordable housing, transportation and infrastructure, parks and open space, neighbourhood character and resources, economic development, and public safety. A Steering Committee formed by participants who were willing to provide additional time and support to the effort worked to develop and refine the ideas that community members shared, to examine methods to address issues raised, and to create a timeline for implementation. Subcommittee meetings were held on schedule.

The Steering Committee for the Bushwick Community Plan included representatives from Bushwick's many community-based organizations, as well as members of Community Board 4, local homeowners, business owners, and interested residents. The Steering Committee was organized into six Subcommittees: Land Use & Zoning, Housing, Economic Development, Neighbourhood Resources, Open Space, and Transportation & Infrastructure. These groups worked directly with City agencies, including the Departments of: City Planning, Housing Preservation & Development, Parks, Transportation, Small Business Services, and more.

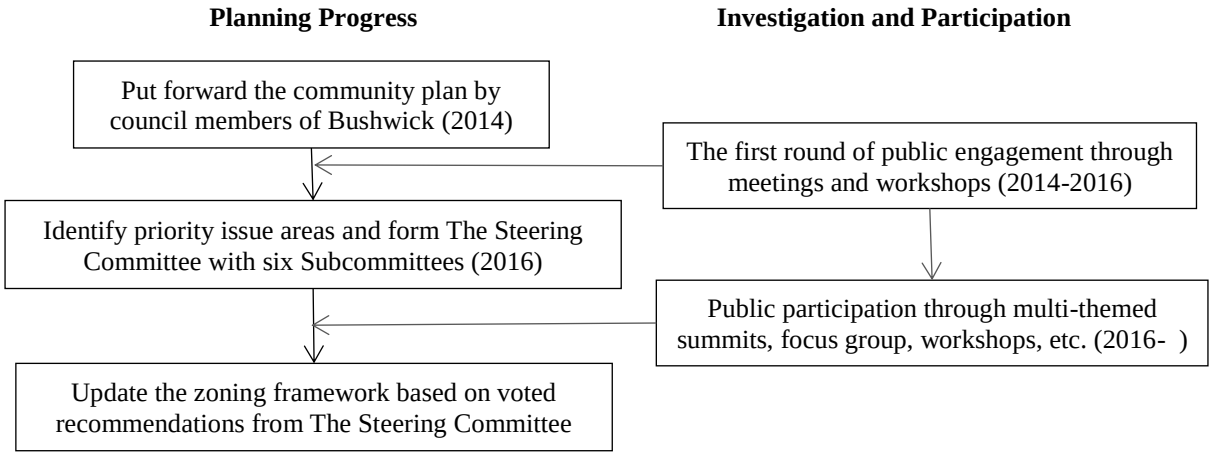


Figure 5.7 Planning participation mechanism of Bushwick, NYC

Some activities were organized separately by the subcommittees. Open Space was one of the topics of the Summit on April 8th, 2017. Entrance activities and small group discussions were organized to gather input from participants. The entrance activities were to understand which parks people are using and where they are coming from in the neighbourhood, and to gather ideas around how people would like to see the edges of parks in terms of design. For the small group discussions there were three parts; first, to understand what issues and ideas for capital improvements people have in specific Bushwick parks; second, to understand what people wish to see in the design of new and improved open spaces in Bushwick; third a discussion around the recommendations.

Table 5.3 The main approaches of public participation in Open Space planning

Approach	Description	Participants
Public Summit	Summits were organized in subtopics to collective public opinions. E.g. the Land Use and Housing Summit on 11 February 2017 and the Open Space, Transportation & Infrastructure Summit on 8 April 2017.	The public
Interactive zoning working sessions	To discuss trade-offs and community priorities related to different zoning options and to get more geographically specific feedback on the planning framework.	Mainly for sub-committee members and open to public
Focus Group	E.g. Art + Culture Focus Group meeting, Commercial Focus Group meeting, and Industrial Focus Group meeting	Identified participants
Project Website	The website was announced as a platform to disseminate information to and receive comments from the public.	The public

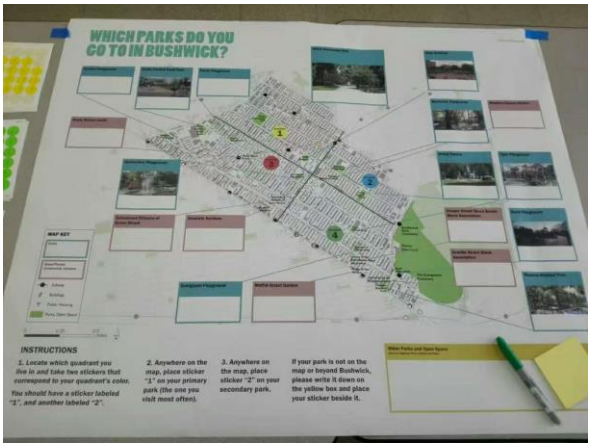


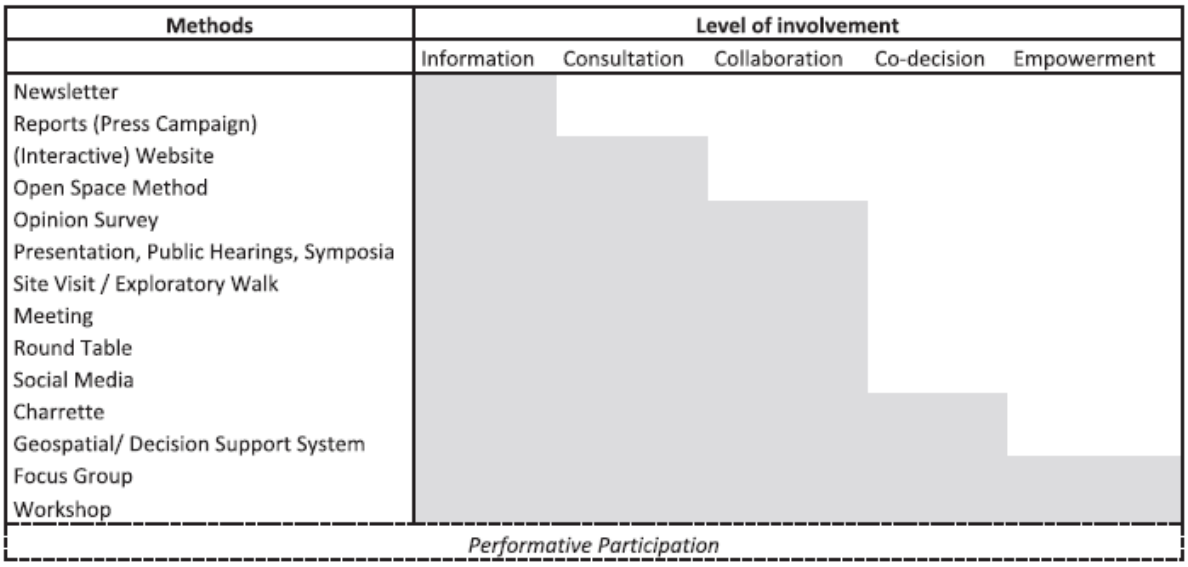
Figure 5.8 Photos of public participation in the Bushwick plan
(taken by the author in Apr.2017)

5.2.5 Comparison of the four cases

For comparison, Figure 5.4 shows the events in four land development and green space supply mechanisms, and the roles of agents, and participation methods of the four cases

Table 5.4 The comparison of participation methods of the four cases

Participation Methods	HSK	HDN	Seestadt	Bushwick
Newsletter	√	√	√	√
Reports	√		√	√
Website	√		√	√
Open Space Method/ Exhibition	√		√	√
Opinion Survey	√		√	
Public forums/ hearings and Symposia	√		√	√
Site visit / Exploratory walk			√	
Meeting / Briefing session	√		√	√
Round Table	√		√	√
Social Media				
Charrette				
Geospatial / Decision Support System				
Focus group			√	√
Workshop	√		√	√



(Vincent et al., 2012)

Figure 5.9 Methods and level of involvement

According to previous studies, different methods of participation imply different level of involvement. Newsletter and Reports are Information level. Consultation level include Website, Open Space Method. Collaboration is reached through Opinion Survey, Presentation, Public Hearings and Symposia, Site visit/ Exploratory walk, Meeting, Round Table, Social Media. The highest levels of Co-decision refer to Charrette, Geospatial/decision support system, focus group, and workshop. Correspondingly, the involvement level of the four cases could be identifies.

5.3 Public Desire in Urban Development

5.3.1 Questionnaire design and data collection

The questionnaire survey aims to know about public desires in urban fringe development. The proposed respondents are the people who live or work in or near the development area, and who will be affected by the development of the specified project. The questions mainly consist of two parts, importance scoring of planning items in 5 aspects and importance sorting of 8 land uses. The questions are not only focused on UGS but integrated with other planning elements and other land uses to better understand the importance of UGS in the whole context of urban planning. Apart from the questions, the questionnaire also contains brief introduction, question of whether they know the plan, and whether/how they participated in the planning process at the beginning, as well as basic personal information at the end.

In the first part of desire investigation, a five-point Likert-type Scale is used by respondents to score 35 items about sustainable development in five aspects of Housing, Industry,

Environment, Transportation, and Culture and facilities. The questions are *"In the future development of xx, do you have the following needs? How much do you need them? (Please tick at the corresponding cells, where 1-Don't need, 2- May Need, 3-Somewhat need, 4-Need it, 5-Highly Need, increasing gradually)"* For each aspect, two questions about their satisfaction degree with the status and the plan are followed. Since the questionnaire was distributed in four different cities of three countries and one region, the content was generalized to be understandable and so was not confined to a specifically localized context. When designing the questions, the selection of the 35 items is referring to the indicators for sustainable cities (Science for Environment Policy, 2015), which reported the best currently available indicator tools for sustainable cities worldwide based on scalability and ease of use.[27] To highlight the component of GS, a few more questions are affiliated in "Environment" section, targeting peoples' attitude in landscape morphology. For example, questions about whether they are satisfied with the current and planned UGS pattern, what is the desired UGS coverage rate, and are they willing to pay for houses with better landscape?

After understanding the context of different land uses, the second part of the questions is about how important UGS is compared with other land uses. People were asked to sort eight land categories according to their importance to planning, including Agriculture, Residential use, Industrial use, Commercial use, Transportation, Green space, Infrastructure, and Facilities. All the land uses are indispensable in peoples' life providing places of living, working, commuting, recreation, studying, etc.; however, land resources are limited. This part was intended to help to explore the relative importance UGS in the condition of competed land market of different land uses. The sample of the questionnaire is attached in Appendix B, while the fuzzy content in "xxx" or "…" are filled according to each case.

The questionnaire surveys were conducted during May. 2016-Oct. 2017 in the four cities of HK, Beijing, Vienna, and New York. To get qualified respondents who are living or working around the designated development projects, the scopes of the surveys were confined to the areas of the four study cases. Most of the respondents were approached randomly at the station, in the community or on the streets. It took 5~10 minutes to fill out one questionnaire. Every respondent received a small gift as reward such as pen, candy, chocolate, tissue, or bottled drink, when they completed the questionnaire. The face-to-face surveys were carried out in HK,

[27] Science for Environment Policy (2015) Indicators for sustainable cities. In-depth Report 12. Produced for the European Commission DG Environment by the Science Communication Unit, UWE, Bristol. Available at: http://ec.europa.eu/science-environment-policy

Vienna and NYC by myself together with one or two student helpers, while in Beijing the questionnaires were initially distributed in a community by the Community Commission and then followed up by using the same kind of face-to face survey. Some questionnaires were not fully completed, especially in the second part of the questions. Therefore, only those with full-filled answers in the two question parts (both the part of scoring and the part of sorting) were regarded as effective samples. Related information was listed in Table 5.5.

Table 5.5 Related information of questionnaire survey

Case	Time	Place	No. of collected questionnaires	No. of effective questionnaires	Effective response rate
HSK, HK	May. 2016 Jun. and Oct. 2017	Around the railway station of HSK	206	169	82.0%
HND, Beijing	May 2016	In Wenquan Town and Sujiatuo Town of HND	250	151	60.4%
Seestadt, Vienna	Sep.–Nov. 2016	Around the railway station of Seestadt	152	134	88.8%
Bushwick, NY	Apr.-May. 2017	In the Community of Bushwick	170	155	91.1%
Total (in summary)	***May. 2016~Oct. 2017***	***Within the areas of the studied cases***	***778***	***609***	***78.3%***

Overall, 778 questionnaires were collected. The total amount of valid responses was 609 with 134~169 effective samples for each case, and the effective response rate of the questionnaire survey is 78.3% in average. Only the effective rate of HND case is below the average level, because in the initial community-distribution stage, many collected questionnaires show repeated answers, which are taken as ineffective samples. The face-to-face surveys in all the four cases featured relatively high quality and high effective rate. The gender and age distribution of the respondents are illustrated in the following figure.

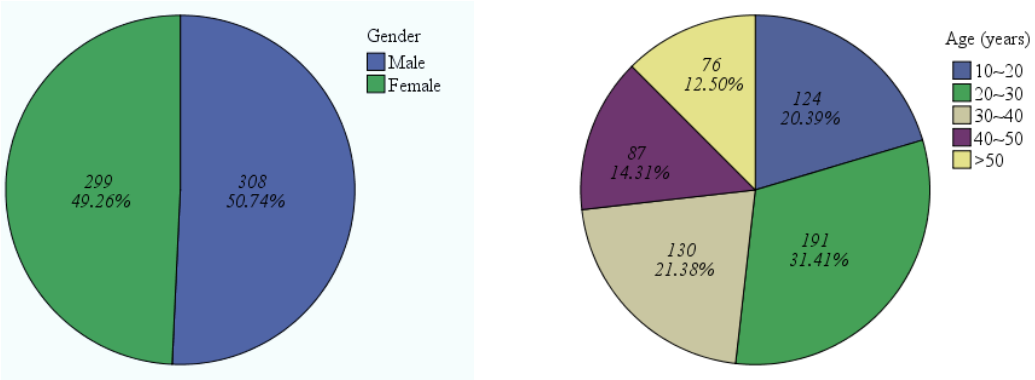


Figure 5.10 Gender distribution (left pie) and age distribution (right pie) of the respondents*

* Note: The label shows the frequency and valid percent.

According to Figure 5.10, the overall respondents of the questionnaire survey were almost evenly split by gender, with males and females making up 50.7% and 49.3% respectively. The survey also covered different age groups in a relatively balanced distribution. As the pie chart shows the group between the ages of 20~30 years is the biggest part with the proportion of 31.4%, followed by the groups of 30~40 years (21.4%) and 10~20 years (20.4%). About 14.3% between the ages of 40~50 and 12.5% of the respondents was over the age of 50. The gender and age distribution of the sample indicates the representativeness of the questionnaire survey, to some extent revealing the opinion of the general public.

5.3.2 Public desire in five aspects of general items

The results indicate which items in five aspects of Housing, Industry, Environment, Transportation, and Culture and facilities are more desired by public. The analysis of the importance scores in 35 items is shown. The Cronbach's Alpha of the sample (N=609) is 0.92, indicating the reliability of this part of the data. One-sample T-test was then carried out to find the differences in scores (Table 5.6). The results show that the mean values of the 35 items range from 2.4 to 4.4. Only the means of 2 items are below 3 (may need to somewhat need), 21 items are between 3~4 (somewhat need to need) and 12 items are over 4 (need to highly need).

Table 5.6 The result of One-Sample T-Test in the five aspects of demanding items (N=609)

Item	Mean	99% Confidence Interval of the Difference*		Item	Mean	99% Confidence Interval of the Difference*	
		Lower	Upper			Lower	Upper
Housing				@3.8	3.501	3.37	3.63
@1.1	3.227	3.09	3.37	@3.9	4.184	4.08	4.28
@1.2	2.992	2.83	3.15	@3.10	4.355	4.26	4.45
@1.3	3.046	2.90	3.19	*Transportation*			
@1.4	3.764	3.64	3.89	@4.1	3.074	2.92	3.23
Industry				@4.2	3.823	3.70	3.95
@2.1	3.125	2.98	3.27	@4.3	3.931	3.81	4.06
@2.2	2.394	2.26	2.53	@4.4	3.995	3.87	4.12
@2.3	3.580	3.43	3.72	@4.5	4.146	4.04	4.25
@2.4	3.199	3.07	3.33	@4.6	4.048	3.94	4.16
@2.5	3.718	3.59	3.84	@4.7	3.898	3.78	4.02

@2.6	3.701	3.58	3.82	*Culture and Facility*			
Environment				@5.1	3.677	3.56	3.80
@3.1	4.176	4.06	4.29	@5.2	3.979	3.88	4.08
@3.2	4.115	4.01	4.22	@5.3	3.943	3.84	4.04
@3.3	4.406	4.31	4.50	@5.4	3.772	3.66	3.88
@3.4	4.328	4.23	4.42	@5.5	3.959	3.85	4.07
@3.5	4.187	4.08	4.29	@5.6	3.824	3.70	3.95
@3.6	4.153	4.05	4.26	@5.7	3.681	3.55	3.81
@3.7	4.018	3.91	4.12	@5.8	4.323	4.22	4.42

***** All the values are significant at the 0.01 level.

Items in the aspects of Environment (@3.x) and Culture and facility (@5.x) were of more concern to the public, while items Housing (@1.x) and Industry (@2.x) got relatively scattered answers. Most of the items in Transportation (@4.x) received high scores except the item @4.1. The boxplot about the importance score of the 35 items was drawn to better illustrate the result.

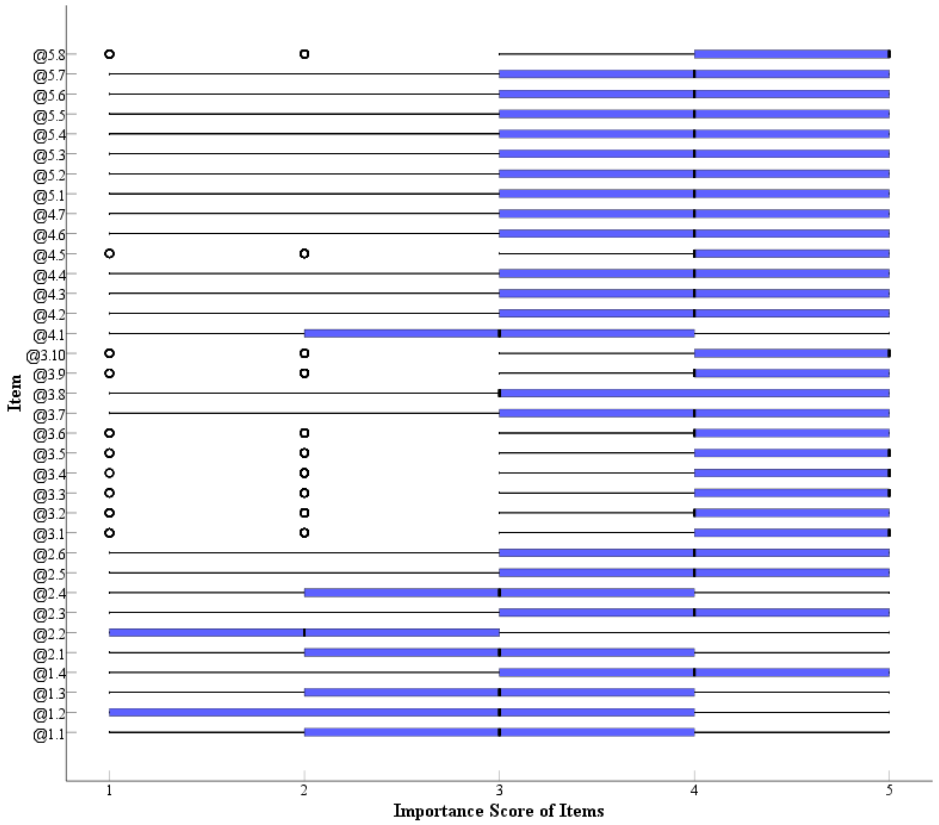


Figure 5.11 The boxplot of the importance score of 36 items

To know whether the scores are differentiated in the four cases, a one-way ANOVA analysis was conducted by "Case". The results show that the scores of all the 35 items are different at a 0.1 significance level, 33 of which are significant at a 0.05 level. It implies that peoples' opinion

in the importance of the items is considerably varied among cases. Focusing on UGS, although the public attached importance to "Environment" in general, the variations in each case required further analysis.

5.3.3 The importance of different land use categories

How important is UGS to public compared with other land uses? Figure 12. represents the rank of the eight land uses. The result of the importance sorting suggests Housing is the most important land use, followed by Transportation and then UGS. Land uses of Infrastructure, Commercial and Facility are not that mattered and ranked in the middle. Agriculture and Industry are not generally favoured by the public in urban fringe development. Accordingly, the importance rank of the land use categories is as follows: 1 Housing > 2 Transportation > 3 Green space > 4 Infrastructure > 5 Commercial use > 6 Facility > 7 Agriculture > 8 Industrial use.

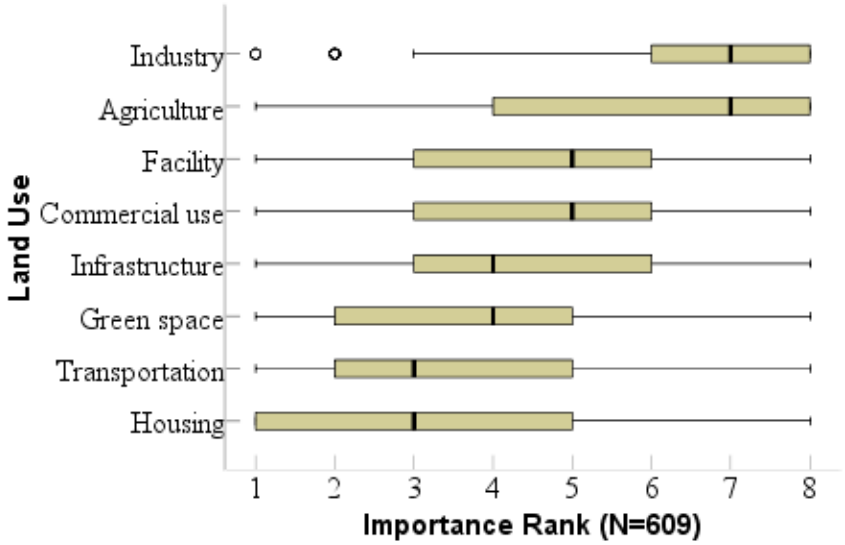


Figure 5.12 The overall importance rank of different land uses

Focusing on each case, a table (Table 5.7) and a clustered boxplot (Figure 5.13) were made to figure out the priority of UGS among different potential land uses. Green space is the most important land use in case of Seestadt and the second important land use in Bushwick. However, in HSK and HDN, Green space is less important in public view, ranked at 4th and 5th correspondingly.

Table 5.7 The importance of different land uses in the four cases based on the mean ranking value

Rank	Land use category and the corresponding Mean value of ranking							
	HSK		HDN		Seestadt		Bushwick	
1	Housing	2.70	Transportation	3.09	*Green space*	*2.65*	Housing	2.67
2	Transportation	2.88	Housing	3.12	Commerce	3.39	*Green space*	*2.97*

3	Infrastructure	3.38	Commerce	4.09	Facility	3.91	Transportation	3.42
4	Facility	3.93	*Green space*	*4.33*	Housing	4.46	Facility	5.01
5	*Green space*	*4.63*	Facility	4.72	Transportation	4.66	Commerce	5.18
6	Commerce	4.96	Infrastructure	4.93	Infrastructure	4.81	Infrastructure	5.26
7	Agriculture	6.67	Agriculture	5.61	Agriculture	5.15	Agriculture	5.39
8	Industry	6.85	Industry	6.11	Industry	6.97	Industry	6.10

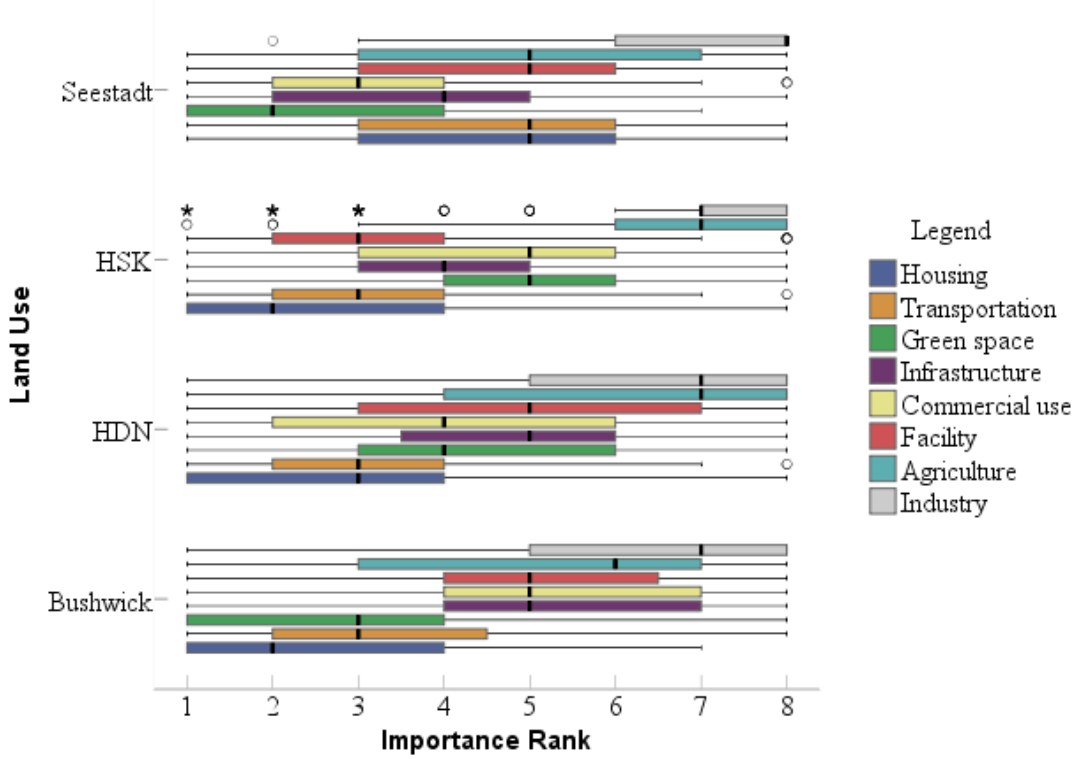


Figure 5.13 The importance rank of different land uses in each case

Although Housing, Transportation and Green Space are the three most important land uses in public view, the significant differences were observed in the four cities. How is the demand of Housing and Transportation related to UGS? If people do not consider UGS is importance in land use planning, is that because they are concerned more about imperative land uses for living and work, such as house and transportation? The answer these questions, a one-way ANOVA together with the post hoc analysis of Least Significant Difference (LSD) was carried out to understanding the difference by comparing between two means from two individual cases.

Table 5.8 Mean difference of the importance rank in four cases (I-J)

Case (I) / Case (J)	HSK	HDN	Seestadt	Bushwick
Mean Rank of Green Space	***4.63***	***4.33***	***2.65***	***2.97***
HSK	-			
HDN	.302	-		

Seestadt	1.984*	1.682*	-	
Bushwick	1.665*	1.363*	-.318	-
Mean Rank of Housing	***2.7***	***3.12***	***4.46***	***2.67***
HSK	-			
HDN	-.421*	-		
Seestadt	-1.764*	-1.343*	-	
Bushwick	.027	.448*	1.792*	-
Mean Rank of Transportation	***2.88***	***3.09***	***4.66***	***3.42***
HSK	-			
HDN	-.217	-		
Seestadt	-1.788*	-1.571*	-	
Bushwick	-.544*	-.327	1.245*	-

* *The mean difference is significant at the 0.05 level.*

Since group sizes of the four cases are unequal, to avoid the errors in getting homogeneous subsets, the results of LSD analysis were further interpreted by fuzzy classification. Based on Table 5.8, if the value of LSD is insignificant at the 0.05 level or less than one rank (-1.00 < LSD < 1.00), then the two cases will be grouped together by brackets. Therefore, the four cases are grouped referring the three land uses as follows. Housing: (HSK > Bushwick > HDN) >> Seestadt, Transportation: (HSK > HDN > Bushwick) >> Seestadt, and Green Space: (Seestadt > Bushwick) >> (HSK > HDN). The greater-than sign ">" implies insignificant difference, while ">>" means significant difference and divided group. E.g. if A >> B, it suggests the subgroup A is of greater order than the subgroup B. The order is assigned as high-low for the classification two subgroups. See Table 5.9.

Table 5.9 The relative importance of the three top-ranked land uses in four cases

Land use	HSK	HDN	Seestadt	Bushwick
Housing	High	High	Low	High
Transportation	High	High	Low	High
Green Space	Low	Low	High	High

According to the table above, the subgroups of the four cases are consistent regarding the importance of Housing and Transportation, as both high or both low. The case of HSK, HDN and Seestadt show the negative relationship between the importance of Housing and UGS. However, this relationship is not supported by all cases. The result of Bushwick shows high demanding degree in all three land uses, indicating public aspiration of UGS is not always competitive with housing or transportation demand. It is suggested that, to some extent, people give priority to built-up uses of housing and transportation compared to non-built uses such as

UGS; however, the competitiveness between built-up and non-built-up uses is not the only factors that effect on public aspirations of UGS.

5.3.4 Public desire for UGS and living environment

Among the 10 items of "Environment", six of them are related to UGS. These items are associated with the quality, quantity as well as the accessibility of the planning UGS. The Mean value of these items in the four cases are illustrated in Figure 5.14. Although variations are observed in cases and items, the degrees of public needs in UGS are relatively high as all the mean values are larger than 3.7.

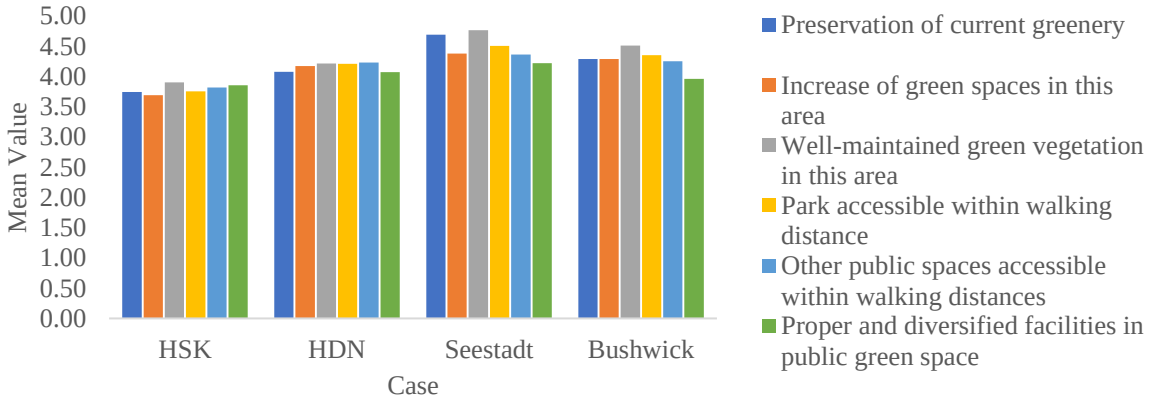


Figure 5.14 The mean importance value of items associated with UGS

The green coverage rate, which means how much of the land is covered by greenery, otherwise be urban grey, influences on the landscape morphology as well as the availability of nature (Ignatieva et al., 2011). How much UGS do the public desire in the development area? Regarding this question, three questions are designed in "Environment" section to better understand their desire for the green coverage rate. Considering the public may not have enough knowledge about what the green coverage means and how it is calculated, the first question is to help them get some subjective perception from the landscape they are familiar with. The second question is to inform them the green coverage rate in the plan if it will apparently change from the current situation and to know about their satisfaction with it, while the third question about their thoughts of the reasonable percentage is to get the quantitative data for the calculation satisfaction index. The questions are:

Are you satisfied with the current green coverage ratio, which is xxx?

□*Very dissatisfied* □*Dissatisfied* □*Neutral* □*Satisfied* □*Very satisfied*

Are you satisfied with the planned green coverage ratio, which is xxx?

□*Very dissatisfied* □*Dissatisfied* □*Neutral* □*Satisfied* □*Very satisfied*

What do you think is the reasonable percentage of green space?

□*<10%* □*10~20%* □*20~30%* □*30~40%* □*40~50%* □*50~60%* □*>60%*

Are you willing to pay more money for the houses with better landscape and living quality?

□*Absolutely no* □*No* □ *Neutral* □*Yes* □*Absolutely yes*

Results of public satisfaction to current UGS Percentage is presented in the left chart of Figure 5.15, while the right chart refers to the satisfaction to planned UGS Percentage. The change of UGS Percentage from current situation was obviously observed only in the plans of case HSK and case HDN. Results of public desired "reasonable percentage of green space" in the four cases are displayed in Figure 5.16.

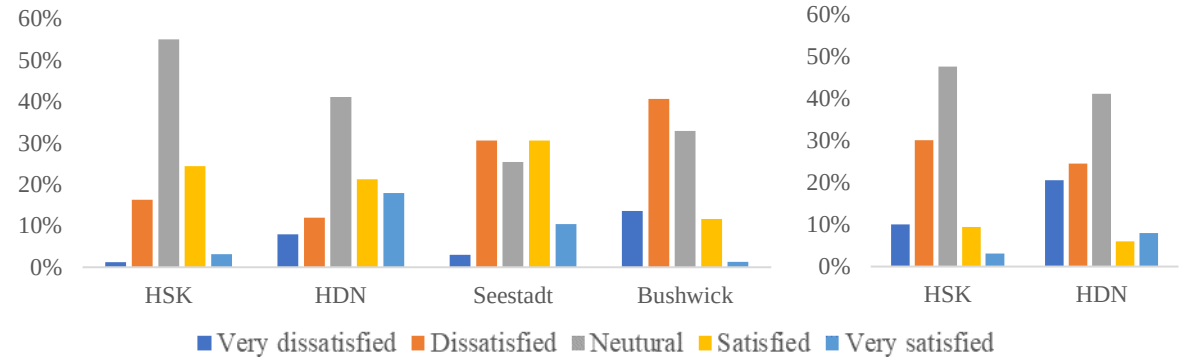


Figure 5.15 The result of satisfaction to current UGS Percentage (left) and planned UGS Percentage (right)

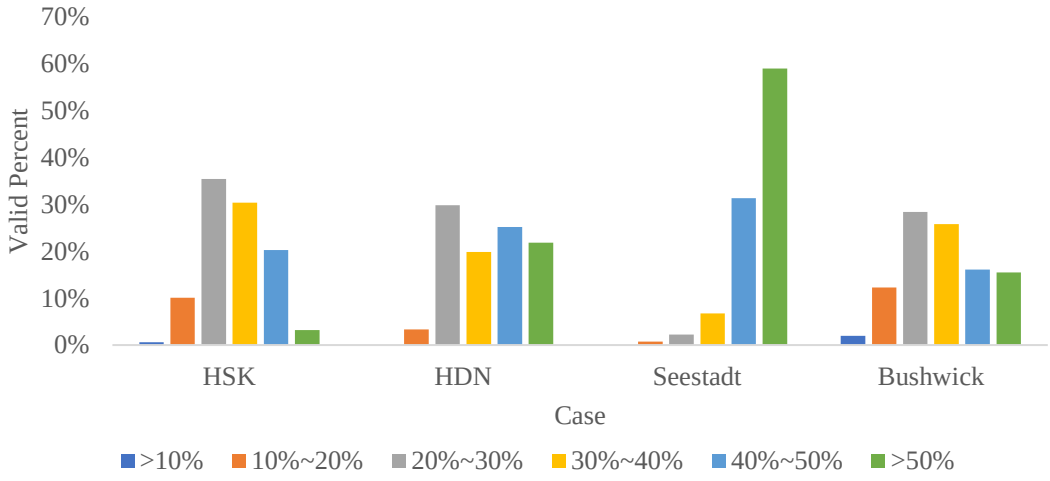


Figure 5.16 The result of the reasonable percentage of green space in four cases

An analysis using ANOVA was done to identify the difference of UGS Percentage between cases, and the LSD was shown to identify how cases are differentiated with each other (Table 5.10). The UGS Percentage was valued in 5 level (1~5), meaning 1=<20%, 2=20%~30%, 3=30%~40%, 4=40%~50%, and 5=>50%. The mean value of the four cases are for HSK, HDN, Seestadt and Bushwick respectively.

Table 5.10 Mean difference of the UGS Percentage in four cases (I-J)

Case (J) \ Case (I)	HSK	HDN	Seestadt	Bushwick
Mean Value	***2.76***	***2.32***	***4.46***	***2.78***
HSK	-			
HDN	-.560*	-		
Seestadt	-1.697*	-1.138*	-	
Bushwick	-0.011	.548*	1.686*	-

* *The mean difference is significant at the 0.05 level.*

By Table 5.10, the UGS Percentage in case of Seestadt is significantly larger than other three cases, while HDN is lower than HSK and Bushwick. In the questionnaire survey, the selection of reasonable percentage refers to the current and planning quantity of UGS in the studied areas. Additionally, the personal perception to UGS may also influence on public choice of the percentage.

Results of public willingness to pay (WTP) for the houses with better landscape and living quality (or to say amenity value) as well as the differences between cases are demonstrated through Figure 5.17 and Table 5.11. WTP was valued in 5 level (1~5), which means 1=Very unwilling, 2=Unwilling, 3=Neutral, 4=Willing, and 5=Very willing.

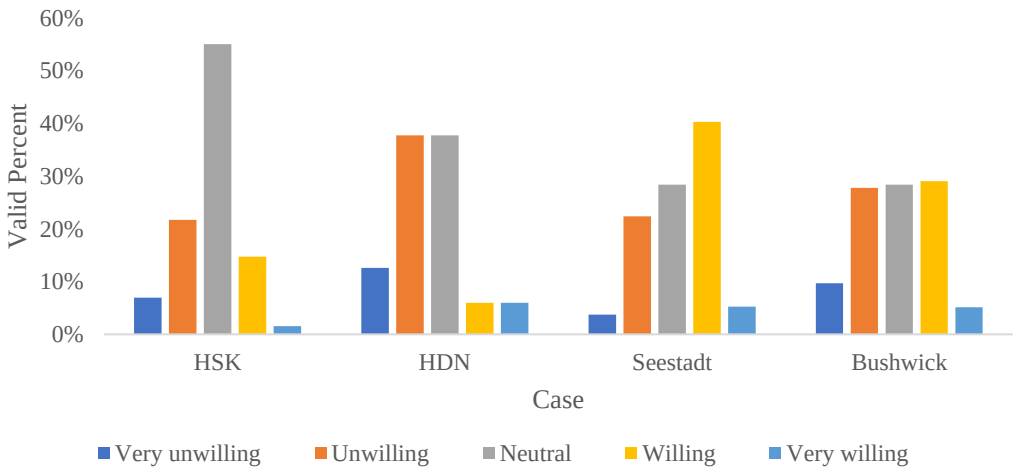


Figure 5.17 The result of the willingness to pay for amenity value in four cases

Table 5.11 Mean difference of the WTP in four cases (I-J)

Case (J) \ Case (I)	HSK	HDN	Seestadt	Bushwick
Mean WTP	***2.82***	***2.55***	***3.21***	***2.92***
HSK	-			
HDN	.293*	-		
Seestadt	-.351*	-.644*	-	
Bushwick	-.086	-.379*	.265*	-

* *The mean difference is significant at the 0.05 level.*

Residents in Seestadt is significantly more willing to pay for the amenity value than other three cases, while people in HDN are less willing than HSK and Bushwick. To compare the view of UGS Percentage in different cases, Table 5.12 is established.

Table 5.12 The comparison of the public views of UGS Percentage in four cases

Case	Current Green Percentage	Mean choice of satisfaction to current Percentage[*a]	Planning Green Percentage	Mean choice of satisfaction to planned Percentage	Mean of reasonable Percentage	WTP
HSK	33%	Neutral (3.12)	19%	Neutral (2.66)	Medium	Medium
HDN	60%	Neutral (3.29)	30%	Neutral (2.56)	Low	Low
Seestadt	50%	Neutral (3.15)	27%	-[*b]	High	High
Bushwick	10%	Dissatisfied (2.46)	-[*c]	-	Medium	Medium

[*]Note: a--the mean value based on the choices of five-point scale (1~5); b—missing data, since the question of satisfaction to planned UGS is not included in the questionnaire; c--No apparent changes from current UGS Percentage.

The analysis in this Section indicates that the attitudes to UGS Percentage considerably vary among cases. Although the satisfaction to UGS Percentage is slightly reduced in HSK and HDN, most people keep neutrality to both current and planned UGS Percentage, suggesting they do not care much about the changes of green coverage. In case of Seestadt, the public aspiration of high UGS Percentage was observed, since their answers to reasonable UGS Percentage concentrated on 40%~50% and >50%. People in Bushwick are dissatisfied with the current situation and want more UGS in their community. Regarding the UGS percentage, residents in Seestadt would apparently like more UGS, followed by Bushwick and HSK in medium level and HDN in low level. The variation of WTP is consistent with the variation of selected reasonable UGS Percentage between cases.

With the data from the questionnaire survey, public desires in urban development, especially their aspiration to UGS are analysed. However, how the UGS pattern is performed regarding public preference and how public preferences are differentiated by demographic characteristics remain to be resolved. In the next section, the performance of the planning UGS layouts will be evaluated based on the analysis of social utility and findings of the questionnaire survey.

5.4 The Social Utility of The UGS provision

5.4.1 Agent-based analysis of social utility

To what extent are the public satisfied with the allocation of UGS in the four cases? To deal with this issue, ArcGIS was used to measure performance of UGS pattern of the four cases and then the social utility of UGS provision for each case was calculated. The social utility of the UGS is calculated based on public desire for UGS, in terms of the amount as well as the

accessibility of UGS. Quantity and Accessibility are chosen as the evaluation factor to show the performance of UGS provision. While the area and distance are the spatial variables to measure the performance of land use pattern, social variables of public-desired UGS percentage and UGS accessibility are used to assess the social utility of the UGS pattern, through two indicators of Coverage Satisfaction Index (CSI) and Accessibility Satisfaction Index (ASI).

When quantifying the public satisfaction in green coverage rate, three principles of (a) no objection to greener design, (b) majority consensus and (c) minimum supply will be obeyed. Assuming respondents who choose a lower percentage as reasonable green coverage rate also accept the choices of higher percentages, since people do not oppose better living environment. It is difficult to reach to the point of unanimous consent due to land limits and diversified opinions, so the minimum UGS percentage that collectively garner the consent of the majority (not less than half) respondents is regarded as the satisfied coverage rate. For example, if 30~40% of the land were supplied for UGS, the people who choose 0~40% as the reasonable green rate will be satisfied, and if their occupation is more than half of the samples, then 40% is regarded as the public satisfied rate green coverage. It is assumed that in one land use pattern, nobody will be satisfied if the occupation of UGS is too small. Based on these principles, the formula for Coverage Satisfaction Index (CSI) is theoretically established.

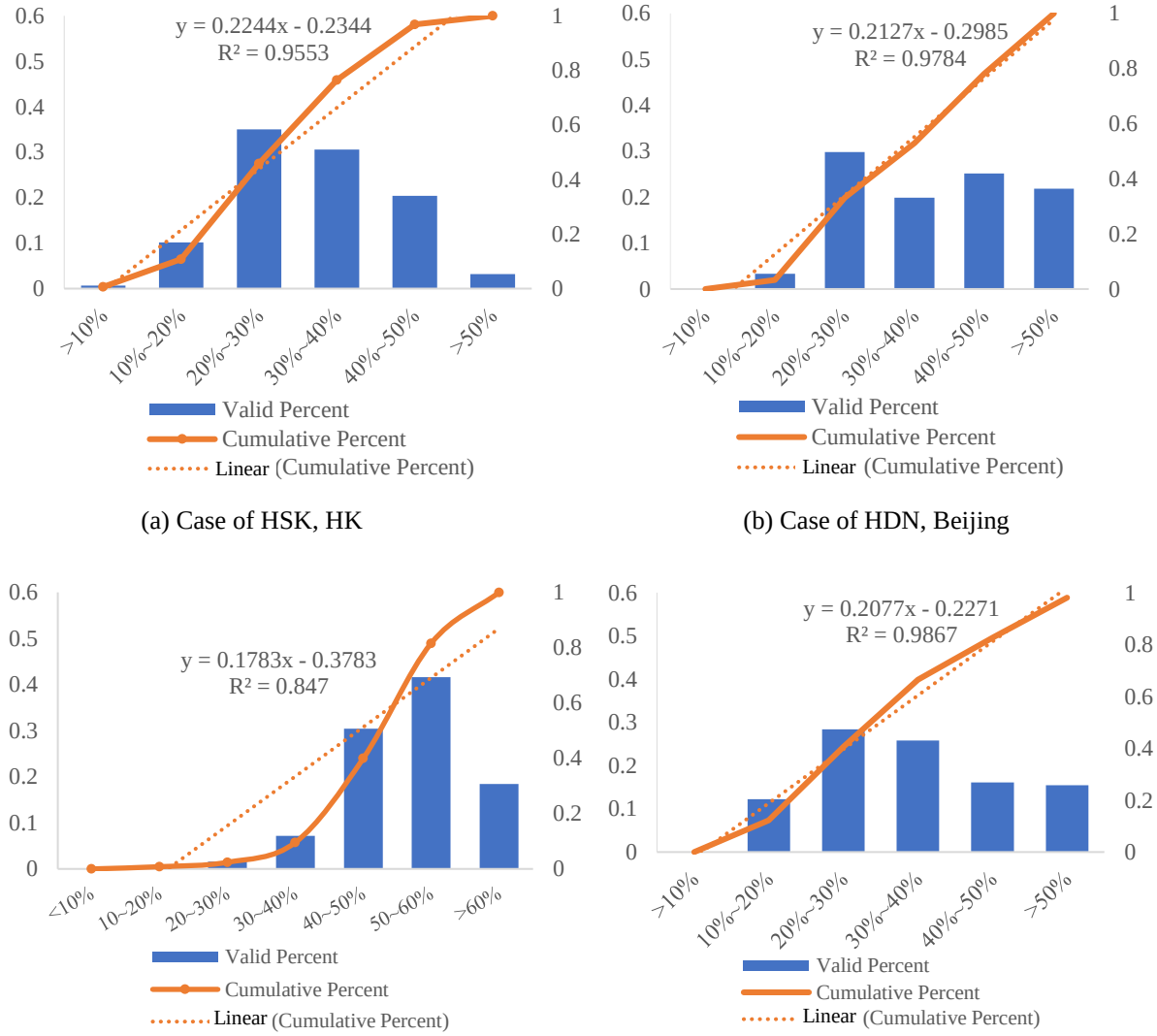
$$CSI = \begin{cases} 0 \ ; \text{if } R_g \leq R_a \\ G_s * (R_g - R_a) \ ; \text{if } R_a < R_g < R_b \\ 1 \ ; \text{if } R_g \geq R_b \end{cases}$$

CSI means Coverage Satisfaction Index of the whole land plot; R_g means the actual green coverage rate； R_a means the minimum green coverage rate that someone starts to be satisfied with; R_b means the satisfied rate of green coverage where the majority (more than half) of public are satisfied with it; G_s means the differential coefficient of satisfaction to green coverage rate between R_a and R_g which is calculated through linear regression.

5.4.2 Coverage Satisfaction Index (CSI) of the four cases

To quantify the public desire for Green Coverage Rate, the cumulative percent of respondents is used to calculate the differential coefficient of satisfaction to green coverage rate (G_s). According to Figure 5.18, the linear fitting equation for cumulative percent was established, while the minimum green coverage rate that someone starts to be satisfied with (R_a) and the

rate that the majority of public are satisfied with (R_b) are determined. The results of the four cases are listed in Table 5.13.



(a) Case of HSK, HK

(b) Case of HDN, Beijing

(c) Case of Seestadt, Vienna

(d) Case of Bushwick, NYC

Figure 5.18 The analysis of public desire for R_g based on questionnaire survey of the four cases

Notes: The "valid percent" for R_g is from the questionnaire survey, based on how many respondents choose this option, the "cumulative percent" is the sum of valid percent below the specific R_g.

Table 5.13 Establishment of the formulae for calculating CSI of the four cases

Case	R_a	R_b	G_s	Formula of CSI			Result of CSI
				If $R_g \leq R_a$	if $R_a < R_g < R_b$	if $R_g \geq R_b$	
HSK	10.4%	32.7%	4.488	0	4.488 (R_g – 0.104)	1	0.39
HDN	14.0%	37.5%	4.254		4.254 (R_g – 0.140)		0.06
Seestadt	21.2%	49.3%	3.566		3.566 (R_g – 0.212)		0.19
Bushwick	10.9%	35.0%	4.154		4.154 (R_g – 0.109)		0.00

The Formula for the calculation of CSI is then formed and illustrated by the graph of Figure 5.19.

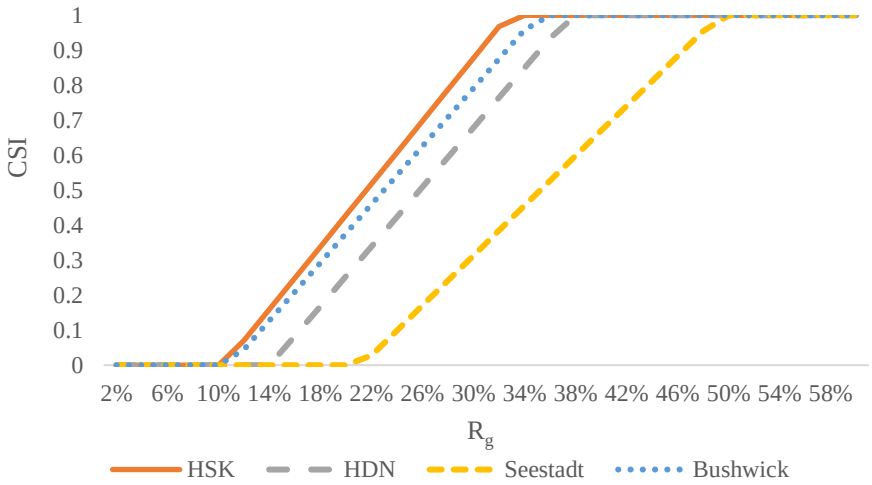


Figure 5.19 The relationship between CSI and R_g in the four cases

5.4.3 Different preferences of public in and between cases

What is the difference in UGS preference among different population groups? To deal with this question, the statistical analysis was conducted to further detect the preference of public regarding the quantity of UGS and the differences in and between cases. The dependent variable is the UGS percentage, which is the reasonable green coverage rate in the development area collected from questionnaire. Population variables of Gender, Age, Education, and Income are used to identify demographic variations of the public. It is assumed that the satisfaction to current UGS percentage as well as willingness to pay (WTP) for UGS may impact on their aspirations to UGS. Therefore, the variable of Current Satisfaction and Willingness will be considered in the analysis. The variable of Gender is nominal while other variables are ordinal. The information of the variables is listed in Table 5.14.

Table 5.14 The values of population variables and UGS preference related variables

Variable	Value and Meaning	Variable	Value and Meaning
GS Percentage	1 - <20%[#] 2 - 20%~30% 3 - 30%~40% 4 - 40%~50% 5 - >50%	Income level (same for different cases)	1 - Extremely low income 2 - Low income 3 - Middle level (average) 4 - High level 5 - Extremely high level
Gender	1 - Male 2 - Female	*Case 1: HSK (Unit: HKD[*])*	*1 - < HK$5000* *2 - HK$5000~ HK$10000* *3 - HK$10000~ HK$20000* *4 - HK$20000~ HK$30000* *5 - > HK$30000*
Age	1 - <20 years 2 - 20~30 years 3 - 30~40 years	*Case 2: HDN (Unit: CNY[*])*	*1 - < ¥3000* *2 - ¥3000~ ¥5000* *3 - ¥5000~ ¥7000*

	4 - 40~50 years 5 - >50 years		*4 - ¥7000 ~¥10000* *5 - > ¥10000*
Education	1 - Primary school and below 2 - Middle school 3 - High school 4 - University and above	*Case 3: Seestadt (Unit: EUR*)*	*1 - < €500* *2 - €500- €1000* *3 - €1000 ~€1500* *4 - €1500 ~€2000* *5 - €2000*
Current satisfaction	1 - Very unsatisfied 2 - Unsatisfied 3 - Neutral 4 - Satisfied 5 - Very satisfied	*Case 4: Bushwick (Unit: USD)*	*1 - < US$1500* *2 - US$1500~ US$3000* *3 - US $3000~ US$45000* *4 - US$4500~ US$6000* *5 - >US$6000*
Willingness to pay	1 - Very unwilling 2 - Unwilling 3 - Neutral 4 - Willing 5 - Very willing	*Note: #the choice of <10% and 10~20% were merged since few respondents chose <10%.* **the exchange rates (in Dec. 2017) are HKD: USD=1 :0.13, CNY: USD=1: 0.15, and EUR: USD=1: 1.18.*	

Statistical analysis is the research method applied in this section, using the software of SPSS. Firstly, ordinal logit regression analysis will be conducted to see how well the selected UGS Percentage can be predicted by other variables, or in other works the integrated relationship between the dependent variable and independent variables. Secondly, if the UGS Percentage could not be predicted, ANOVA analysis will be processed to explore what is the impact factor and how will it impact on the dependent variable. The flowchart of the analysis is illustrated in Figure 5.20.

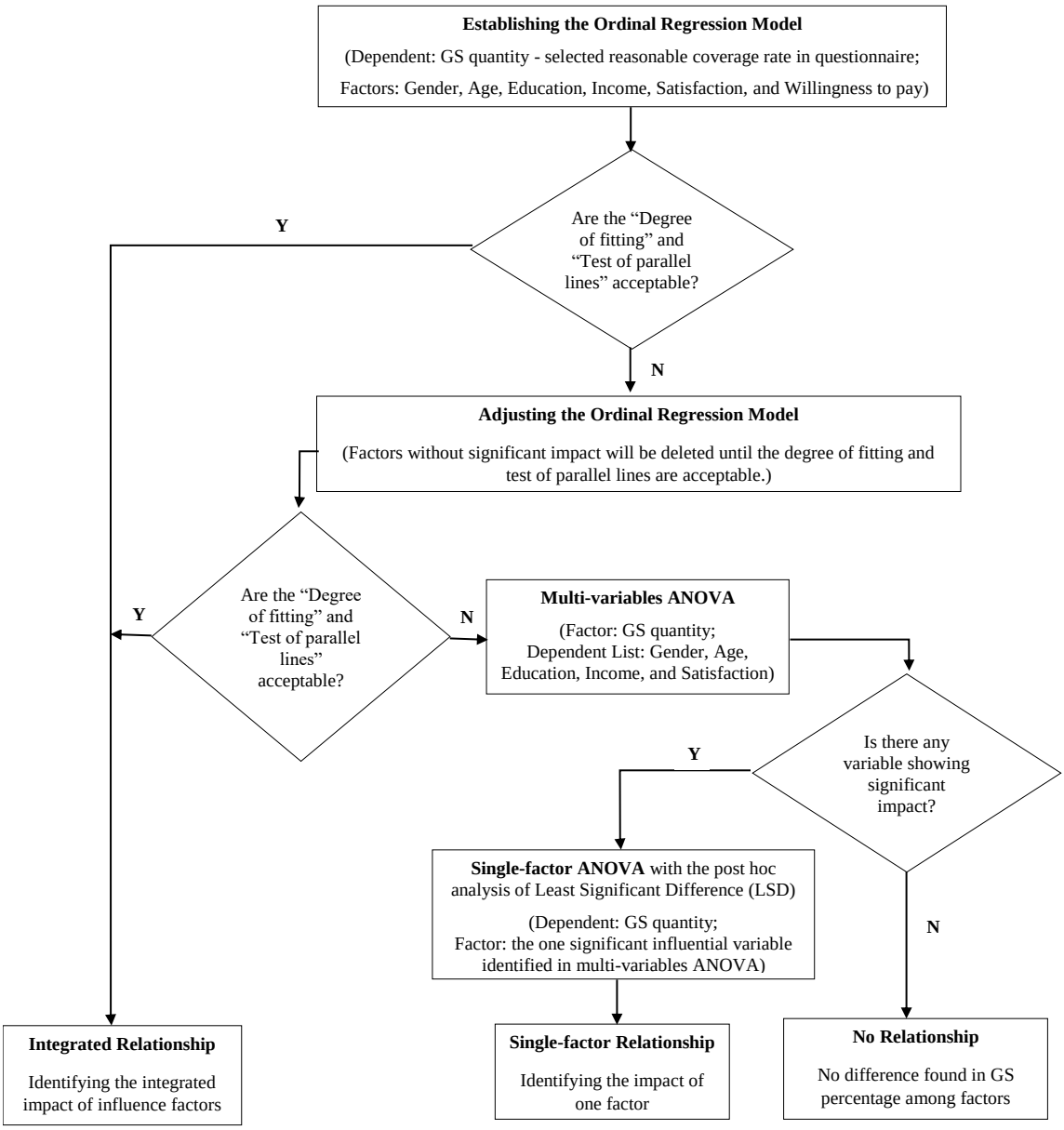


Figure 5.20 The flowchart of analysis regarding the relationships between variables and UGS percentage

5.4.3.1 The overall sample

Regarding the overall sample of the four cases, some demographic data were missing. E.g. a few respondents did not want to declare their age or income. The samples with full demographic information, including gender, age, income level, are regarded effective for this part. The number of overall four-cases sample is 502, with 85 in HSK, 151 in HDN, 132 in Seestadt, and 134 in Bushwick. To find the impact factor on public desire of the quantity of UGS, an ordinal regression model was run using the function of "Analyze → Regression → Ordinal" in SPSS. The dependent variable is UGS percentage, and the factors are Case No., Gender. Age, Education, and Income level.

Table 5.15 The result of parallel lines test of ordinal regression model (UGS percentage)

Test of Parallel Lines[a]				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	974.965			
General	859.716[b]	115.250[c]	60	0.000

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

According to the result of parallel lines test Table 5.15, it suggests the general model (with separate parameters for each category) gives a significant improvement in the model fit, indicating the low validity of established model. [28] It may attribute to the remarkable differences between cases. Due to the significant difference between cases, analysis of overall sample was insufficient and case by case analysis was conducted as follows.

5.4.3.2 HSK

Referring to the case of HSK, an ordinal logit regression model was run with UGS percentage as the dependent variable and Gender. Age, Education level, Income level and Current satisfaction as factors. Table 5.16 shows the result of the model.

Table 5.16 The result of ordinal regression of HSK case (UGS Percentage as dependent variable)

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	237.626			
Final	204.102	33.525	18	0.014

Link function: Logit.

Parameter Estimates							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Percentage = 1]	-2.911	1.814	2.575	1	0.109	-6.467	0.644
	[Percentage = 2]	-0.754	1.798	0.176	1	0.675	-4.278	2.769
	[Percentage = 3]	1.122	1.790	0.393	1	0.531	-2.387	4.630
	[Percentage = 4]	3.699	1.863	3.942	1	0.047	0.047	7.350
Location	[Gender=1]	-0.478	0.465	1.057	1	0.304	-1.388	0.433
	[Gender=2]	0[a]			0			
	[Age=1]	2.117**	1.017	4.331	1	0.037	0.123	4.111
	[Age=2]	-0.119	0.737	0.026	1	0.872	-1.564	1.326
	[Age=3]	1.703**	0.772	4.869	1	0.027	0.190	3.216
	[Age=4]	2.007***	0.770	6.792	1	0.009	0.498	3.516
	[Age=5]	0[a]			0			
	[Education=1]	-2.158*	1.123	3.696	1	0.055	-4.358	0.042

[28] https://www.ibm.com/support/knowledgecenter/en/SSLVMB_sub/spss/tutorials/plum_germcr_parallel.html

[Education=2]	-1.835**	0.733	6.272	1	0.012	-3.272	-0.399
[Education=3]	-1.593**	0.660	5.818	1	0.016	-2.888	-0.299
[Education=4]	0[a]			0			
[Income=1]	0.382	0.900	0.180	1	0.671	-1.382	2.146
[Income=2]	1.269	0.870	2.128	1	0.145	-0.436	2.973
[Income=3]	0.402	0.828	0.235	1	0.628	-1.222	2.025
[Income=4]	1.985**	0.900	4.864	1	0.027	0.221	3.748
[Income=5]	0[a]			0			
[Current Satisfaction=2]	1.825**	0.717	6.479	1	0.011	0.420	3.230
[Current Satisfaction=3]	0.804	0.594	1.835	1	0.176	-0.359	1.968
[Current Satisfaction=4]	0[a]			0			
[Willingness=1]	-2.134	1.680	1.613	1	0.204	-5.428	1.159
[Willingness=2]	-2.273	1.525	2.222	1	0.136	-5.262	0.715
[Willingness=3]	-1.002	1.440	0.484	1	0.486	-3.825	1.820
[Willingness=4]	-0.835	1.623	0.265	1	0.607	-4.016	2.347
[Willingness=5]	0[a]			0			

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	204.102			
General	162.434[b]	41.668[c]	54	0.890

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

The results suggest Age, Education, Income and Current satisfaction have impact on public desired UGS Percentage. The increase of Age and a lower Education level predicted less UGS percentage, while diverse views are expressed by different income groups. Age groups of <20, 30~40, and 40~50 ask for more UGS percentage than older people (>40) by about two levels with significant estimate valued 2.12, 1.70, and 2.00. Compared to people with education level of university and above, the estimates are -2.16, -1.84, and -1.59 for individuals at primary and below, middle, and high school levels. High-income (income=4) group presented higher percent than extremely high-income (income=5) population, and the statistically significant estimate is 1.99. Other income groups also express higher percentage than extremely high-income income, although the estimate is statistically insignificant. Individuals who are dissatisfied (Current Satisfaction=2) with the current UGS percentage tend to choose higher UGS percentage.

5.4.3.3 HDN

For HDN, the first established ordinal logit regression model was not fitting (Sig. > 0.05). Then, the factor of Gender was excluded since it did not show any impact in the first model. The second model was run with UGS percentage as the dependent variable and Age, Education level, Income level and Current satisfaction as factors. The results of the model are listed below.

Table 5.17 The result of ordinal regression of HDN case (UGS percentage as dependent variable)

Model Fitting Information								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	
Intercept Only		232.656						
Final		200.095		32.562		17	0.013	
Link function: Logit.								
Parameter Estimates								
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Percentage = 1]	-2.725	1.796	2.302	1	0.129	-6.245	0.795
	[Percentage = 2]	-0.601	1.785	0.114	1	0.736	-4.099	2.897
	[Percentage = 3]	1.254	1.780	0.497	1	0.481	-2.234	4.743
	[Percentage = 4]	3.856	1.851	4.341	1	0.037	0.228	7.483
Location	[Age=1]	2.173**	1.014	4.596	1	0.032	0.186	4.161
	[Age=2]	-0.018	0.723	0.001	1	0.980	-1.435	1.398
	[Age=3]	1.840**	0.767	5.756	1	0.016	0.337	3.343
	[Age=4]	2.218*	0.747	8.820	1	0.003	0.754	3.682
	[Age=5]	0[a]			0			
	[Education=1]	-1.904*	1.100	2.998	1	0.083	-4.059	0.251
	[Education=2]	-1.756**	0.727	5.830	1	0.016	-3.181	-0.331
	[Education=3]	-1.492**	0.656	5.177	1	0.023	-2.778	-0.207
	[Education=4]	0[a]			0			
	[Income=1]	0.461	0.897	0.264	1	0.607	-1.297	2.220
	[Income=2]	1.235	0.868	2.025	1	0.155	-0.466	2.937
	[Income=3]	0.470	0.827	0.323	1	0.570	-1.150	2.090
	[Income=4]	1.942**	0.897	4.689	1	0.030	0.184	3.700
	[Income=5]	0[a]			0			
	[CurrentGSSatisfaction=2]	1.841***	0.716	6.618	1	0.010	0.439	3.244
	[CurrentGSSatisfaction=3]	0.680	0.588	1.338	1	0.247	-0.472	1.832
	[CurrentGSSatisfaction=4]	0[a]			0			
	[Willingness=1]	-2.295	1.679	1.868	1	0.172	-5.585	0.996
	[Willingness=2]	-2.391	1.524	2.462	1	0.117	-5.377	0.596
	[Willingness=3]	-1.165	1.438	0.656	1	0.418	-3.983	1.653
	[Willingness=4]	-1.222	1.598	0.585	1	0.445	-4.353	1.910

[Willingness=5]	0[a]	0

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	200.095			
General	159.236[b]	40.859[c]	51	0.844

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.
a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

According to the table above, it is suggested Age, Education, Income and Current satisfaction are significant factors in determining public desired UGS Percentage. The results of HND is considerably similar with the case of HSK. Younger people (Age=1, Age=3, and Age=4), more-educated (Education=4) group, and people who are dissatisfied (Current Satisfaction=2) with the current UGS percentage express higher UGS percentage. In term of Income, lower UGS percentage is observed in group of extremely high-income (income=5) than other four income groups, although only estimate of high-income (income=4) is statistically significant.

5.4.3.4 Seestadt

In the case of Seestadt, the fitting degree of the ordinal regression models are not acceptable. Therefore, an ANOVA was done to determine the differences among group means. The results are presented in Table 5.18.

Table 5.18 The result of ANOVA in Seestadt case (UGS Percentage as factor)

Dependent List		Sum of Squares	df	Mean Square	F	Sig.
Gender	Between Groups	1.123	4	0.281	1.128	0.346
	Within Groups	31.605	127	0.249		
	Total	32.727	131			
Age	Between Groups	3.210	4	0.802	0.664	0.618
	Within Groups	153.419	127	1.208		
	Total	156.629	131			
Education	Between Groups	0.496	4	0.124	0.301	0.877
	Within Groups	52.383	127	0.412		
	Total	52.879	131			
Income	Between Groups	8.214	4	2.054	1.035	0.392
	Within Groups	251.968	127	1.984		
	Total	260.182	131			

Current Satisfaction	Between Groups	4.280	4	1.070	0.939	0.444
	Within Groups	144.690	127	1.139		
	Total	148.970	131			
Willingness	Between Groups	0.450	4	0.112	0.114	0.977
	Within Groups	125.028	127	0.984		
	Total	125.477	131			

The results above suggest the means of UGS Percentage in different groups regarding Gender, Age, Education, Income and Satisfaction are not significantly varied, implying the public preference in UGS Percentage in Seestadt could be considered homogeneous.

5.4.3.5 Bushwick

Similar to Seestadt, the fitting degree of the ordinal regression models are not acceptable, and an ANOVA was done to figure out the differences among group means. Age is the only influential variable, as the means of UGS percentage between different Age groups are unequal. See Table 5.19.

Table 5.19 The result of ANOVA in Bushwick case (UGS Percentage as factor)

Dependent List		Sum of Squares	df	Mean Square	F	Sig.
Gender	Between Groups	2.190	5	0.438	1.795	0.118
	Within Groups	31.243	128	0.244		
	Total	33.433	133			
Age**	Between Groups	10.128	5	2.026	2.403	0.040
	Within Groups	107.909	128	0.843		
	Total	118.037	133			
Education	Between Groups	1.261	5	0.252	0.752	0.586
	Within Groups	42.889	128	0.335		
	Total	44.149	133			
Income	Between Groups	4.630	5	0.926	0.670	0.647
	Within Groups	176.802	128	1.381		
	Total	181.433	133			
Current Satisfaction	Between Groups	2.867	5	0.573	0.681	0.638
	Within Groups	107.730	128	0.842		
	Total	110.597	133			
Willingness	Between Groups	1.564	5	0.313	0.256	0.936
	Within Groups	156.317	128	1.221		
	Total	157.881	133			

To further identify how the means of several Age groups are varied, a one-way ANOVA together with the post hoc analysis of LSD was conducted, results shown in Table 5.20.

Table 5.20 The result of ANOVA and LSD regarding public selected UGS quantity in Bushwick (by Age)

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Between Groups		22.516	4	5.629	3.847	0.005
Within Groups		188.767	129	1.463		
Total		211.284	133			
(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	.934*	0.431	0.032	0.08	1.79
	3	.940*	0.450	0.039	0.05	1.83
	4	1.830*	0.489	0.000	0.86	2.80
	5	0.978	0.675	0.150	-0.36	2.31
2	1	-.934*	0.431	0.032	-1.79	-0.08
	3	0.006	0.250	0.981	-0.49	0.50
	4	.896*	0.316	0.005	0.27	1.52
	5	0.044	0.562	0.938	-1.07	1.16
3	1	-.940*	0.450	0.039	-1.83	-0.05
	2	-0.006	0.250	0.981	-0.50	0.49
	4	.890*	0.341	0.010	0.21	1.57
	5	0.038	0.576	0.948	-1.10	1.18
4	1	-1.830*	0.489	0.000	-2.80	-0.86
	2	-.896*	0.316	0.005	-1.52	-0.27
	3	-.890*	0.341	0.010	-1.57	-0.21
	5	-0.853	0.608	0.163	-2.06	0.35
5	1	-0.978	0.675	0.150	-2.31	0.36
	2	-0.044	0.562	0.938	-1.16	1.07
	3	-0.038	0.576	0.948	-1.18	1.10
	4	0.853	0.608	0.163	-0.35	2.06

According to the table above, 1st Age group (<20 years) is significantly greater than 2nd, 3rd and 4th group, while 2nd and 3rd groups are significantly greater than 4th group. It suggests the teenagers (<20 years) prefer larger UGS percent than young people (20~40 years), and young people prefer larger UGS percentage than middle-aged and elderly people (>40 years). Negative relationship was found between Age and the preferred UGS percentage in Bushwick.

5.4.4 Different utility of public in and between cases

According to section 5.4.3, people generally would like more UGS. However, what will their utility be changed if taken externality into consideration? As suggested in the previous study,

the increasing use of green strategies as primarily market-driven endeavours resulted in unequal distribution where middle class and higher income groups get benefits at the expense of less privileged residents; in the meanwhile, gentrification was an unexpected result of greening projects (Haase et al., 2017). The variable of Willingness to Pay (WTP) for UGS, which means how much people prefer to buy properties with higher price but better designed landscape, will impact on the utility of public since the provision of UGS may combined with the increasing property price. To find the differentiation of WTP among the public, statistical analysis was conducted for overall sample as well the individual cases, using the same flowchart in Figure 5.20.

5.4.4.1 The overall sample

Referring to the overall sample, an ordinal logit regression model was run with dependent variable of Willingness and the factors of Case No., Gender, Age, Education, and Income level. Current satisfaction was excluded regarding the fitting degree of the model. The value (1~5) of Willingness means 1-Very unwilling, 2-Unwilling, 3-Neutral, 4-Willing, and 5-Very willing. The information of the model is presented in Table 5.21.

Table 5.21 The result of ordinal regression of the four cases (Willingness to pay as dependent variable)

Model Fitting Information								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	
Intercept Only		1035.284						
Final		959.201		76.083		15	0.000	
Parameter Estimates								
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Willingness = 1]	-2.957	0.425	48.301	1	0.000	-3.790	-2.123
	[Willingness = 2]	-0.890	0.400	4.950	1	0.026	-1.674	-0.106
	[Willingness = 3]	0.737	0.398	3.425	1	0.064	-0.043	1.518
	[Willingness = 4]	2.828	0.435	42.255	1	0.000	1.975	3.681
Location	[Case=HSK]	-0.351	0.278	1.598	1	0.206	-0.896	0.193
	[Case=HDN]	-0.481*	0.269	3.201	1	0.074	-1.007	0.046
	[Case=Seestadt]	0.229	0.245	0.876	1	0.349	-0.251	0.709
	[Case=Bushwick]	0[a]			0			
	[Gender=1]	0.250	0.169	2.189	1	0.139	-0.081	0.581
	[Gender=2]	0[a]			0			
	[Age=1]	0.622*	0.345	3.257	1	0.071	-0.053	1.297
	[Age=2]	0.292	0.297	0.970	1	0.325	-0.289	0.874
	[Age=3]	0.305	0.304	1.004	1	0.316	-0.292	0.902

[Age=4]	0.217	0.314	0.478	1	0.489	-0.398	0.833
[Age=5]	0[a]			0			
[Education=1]	-1.324**	0.539	6.041	1	0.014	-2.380	-0.268
[Education=2]	-0.196	0.284	0.478	1	0.489	-0.753	0.360
[Education=3]	0.283	0.218	1.684	1	0.194	-0.145	0.712
[Education=4]	0[a]			0			
[Income=1]	-1.174***	0.344	11.633	1	0.001	-1.848	-0.499
[Income=2]	-0.723**	0.309	5.471	1	0.019	-1.329	-0.117
[Income=3]	-0.114	0.317	0.131	1	0.718	-0.735	0.506
[Income=4]	-0.165	0.344	0.231	1	0.631	-0.838	0.508
[Income=5]	0[a]			0			

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	959.201			
General	945.277[b]	13.924[c]	45	1.000

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

Referring to Table 5.21, the factor of Case No. has impact on the result of WTP. For example, the WTP of residents in HDN is significantly less than in Bushwick, and much less than in Seestadt, which is already described in Section 5.3.4. However, in contrast to UGS percentage, the differences of WTP between cases are not that dominant to interfere the performance of the regression model. Age, Education and Income were found influential to WTP in the overall sample. The positive estimate of [Age=1] suggests teenagers are more willing to pay for the amenity value of UGS, while the negative coefficients of [Education=1], [Income=1] and [Income= 2] indicate that less-educated and low-income residents are less willing to pay.

5.4.4.2 HSK

For the case HSK, the factors of Gender and Age were excluded since they did not show any impact in the initial model which did not perform well. The optimized model was established with WTP as the dependent variable and Education, Income level and Current satisfaction as factors. See Table 5.22 for the results of the model.

Table 5.22 The result of ordinal regression of HSK case (WTP as dependent variable)

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	159.682			
Final	134.140	25.543	9	0.002

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Willingness = 1]	-3.756	0.891	17.770	1	0.000	-5.502	-2.010
	[Willingness = 2]	-1.596	0.769	4.303	1	0.038	-3.104	-0.088
	[Willingness = 3]	1.349	0.760	3.146	1	0.076	-0.142	2.839
	[Willingness = 4]	3.467	1.004	11.917	1	0.001	1.498	5.435
Location	[Education=1]	-2.191**	0.981	4.995	1	0.025	-4.113	-0.270
	[Education=2]	0.767	0.613	1.566	1	0.211	-0.434	1.967
	[Education=3]	1.154**	0.586	3.876	1	0.049	0.005	2.303
	[Education=4]	0[a]			0			
	[Income=1]	-0.809	0.787	1.058	1	0.304	-2.351	0.733
	[Income=2]	-1.569	0.851	3.398	1	0.065	-3.237	0.099
	[Income=3]	-0.083	0.820	0.010	1	0.920	-1.690	1.525
	[Income=4]	-0.480	0.885	0.294	1	0.588	-2.214	1.254
	[Income=5]	0[a]			0			
	[Current Satisfaction=2]	-1.583**	0.693	5.225	1	0.022	-2.940	-0.226
	[Current Satisfaction=3]	-0.415	0.533	0.607	1	0.436	-1.461	0.630
	[Current Satisfaction=4]	0[a]			0			

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	134.140			
General	113.173[b]	20.967[c]	27	0.788

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.
a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

The model identified only two significant variables, Education and Current Satisfaction. A lower education level (Education=1) is associated with lower WTP. However, the negative relationship between Education and WTP is not detected, since the group of high school educated (Education=3) expresses significantly higher WTP than university and above

(Education=4). Apart from the influence of Education, the population dissatisfied (Current Satisfaction=2) with the current UGS percentage would pay more for better living environment.

5.4.4.3 HDN

In case of HDN, the first established ordinal logit regression model was not fitting (Sig. > 0.05). Then, the factor of Gender and Current satisfaction were excluded since no impact was found in the first model. The second model was run with WTP as the dependent variable and Age, Education level, and Income level as factors. The results refer to the Table below.

Table 5.23 The result of ordinal regression of HDN case (WTP as dependent variable)

Model Fitting Information								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	
Intercept Only		222.495						
Final		199.934		22.561		11	0.020	
Link function: Logit.								
Parameter Estimates							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[Willingness = 1]	-4.885	1.259	15.058	1	0.000	-7.353	-2.418
	[Willingness = 2]	-2.809	1.240	5.132	1	0.023	-5.240	-0.379
	[Willingness = 3]	-0.515	1.217	0.179	1	0.672	-2.901	1.871
	[Willingness = 4]	0.351	1.210	0.084	1	0.772	-2.021	2.723
Location	[Age=1]	-0.097	0.482	0.041	1	0.841	-1.042	0.848
	[Age=2]	-0.338	0.550	0.379	1	0.538	-1.415	0.739
	[Age=3]	0.042	0.514	0.007	1	0.935	-0.966	1.050
	[Age=4]	0.558	0.516	1.170	1	0.279	-0.453	1.569
	[Age=5]	0[a]			0			
	[Education=1]	-1.110	0.868	1.633	1	0.201	-2.811	0.592
	[Education=2]	-0.381	0.528	0.520	1	0.471	-1.417	0.655
	[Education=3]	0.311	0.477	0.427	1	0.513	-0.623	1.246
	[Education=4]	0[a]			0			
	[Income=1]	-2.663**	1.211	4.830	1	0.028	-5.037	-0.288
	[Income=2]	-2.930**	1.182	6.139	1	0.013	-5.247	-0.612
	[Income=3]	-1.697	1.260	1.815	1	0.178	-4.165	0.772
	[Income=4]	-3.564**	1.559	5.223	1	0.022	-6.621	-0.508
	[Income=5]	0[a]			0			
Link function: Logit.								
a. This parameter is set to zero because it is redundant.								
Test of Parallel Lines[a]								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	

Null Hypothesis	199.934			
General	179.047[b]	20.887[c]	33	0.950

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

Accordingly, only Income was estimated as the significant variable, and only individuals with extremely high income (Income=5) are associated with higher WTP. The remaining factors are statistically insignificant in this model. However, the results show that WTP is negatively related to Age (in case of Age>2) and Education level.

5.4.4.4 Seestadt

In the case of Seestadt, the fitting degree of the ordinal regression models are not accessible Therefore, the ANOVA was carried out to determine the differences among group means. The results are presented in Table 5.24.

Table 5.24 The result of ANOVA in Seestadt case (WTP as factor)

Dependent List		Sum of Squares	df	Mean Square	F	Sig.
Gender	Between Groups	0.390	4	0.098	0.383	0.820
	Within Groups	32.337	127	0.255		
	Total	32.727	131			
Age	Between Groups	2.955	4	0.739	0.611	0.656
	Within Groups	153.673	127	1.210		
	Total	156.629	131			
Education	Between Groups	1.244	4	0.311	0.765	0.550
	Within Groups	51.634	127	0.407		
	Total	52.879	131			
Income	Between Groups	10.727	4	2.682	1.365	0.250
	Within Groups	249.454	127	1.964		
	Total	260.182	131			
Current Satisfaction	Between Groups	1.398	4	0.350	0.301	0.877
	Within Groups	147.572	127	1.162		
	Total	148.970	131			

As Table 5.24 suggested, the means of WTP are not significantly differentiated in population groups, and none of the demographic factors, e.g. Gender, Age, Education, Income and

Satisfaction have impact on WTP in Seestadt. Similar with the homogeneous preference of UGS Percentage, the attribute of WTP could also be considered as the same in the public of Seestadt.

5.4.4.5 Bushwick

In the ordinal regression model of Bushwick, Gender, Education and Income were statistically significant factors in predicting WTP. The model information and the coefficients are shown in the following table.

Table 5.25 The result of ordinal regression of Bushwick case (WTP as dependent variable)

Model Fitting Information								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	
Intercept Only		157.306						
Final		129.592		27.714		8	0.001	
Link function: Logit.								
Parameter Estimates								
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Willingness = 1]	-3.509	0.680	26.604	1	0.000	-4.842	-2.176
	[Willingness = 2]	-1.294	0.606	4.558	1	0.033	-2.482	-0.106
	[Willingness = 3]	-0.117	0.596	0.039	1	0.844	-1.286	1.051
	[Willingness = 4]	2.288	0.657	12.114	1	0.001	0.999	3.576
Location	[Gender=1]	0.697**	0.333	4.371	1	0.037	0.044	1.350
	[Gender=2]	0[a]			0			
	[Education=1]	-1.876	1.360	1.901	1	0.168	-4.542	0.791
	[Education=2]	-0.279	0.884	0.100	1	0.752	-2.011	1.454
	[Education=3]	0.878	0.597	2.164	1	0.141	-0.292	2.047
	[Education=4]	0[a]			0			
	[Income=1]	-2.456***	0.726	11.426	1	0.001	-3.879	-1.032
	[Income=2]	-0.874	0.626	1.951	1	0.162	-2.101	0.352
	[Income=3]	-1.172*	0.660	3.154	1	0.076	-2.465	0.121
	[Income=4]	-0.580	0.728	0.636	1	0.425	-2.006	0.846
	[Income=5]	0[a]			0			
Link function: Logit.								
a. This parameter is set to zero because it is redundant.								
Test of Parallel Lines[a]								
Model		-2 Log Likelihood		Chi-Square		df	Sig.	
Null Hypothesis		129.592						
General		107.734[b]		21.859[c]		24	0.588	

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

In regard of the significantly positive value of [Gender=1], men in Bushwick tend to be more willing to pay for the amenity value than women. Residents with extremely high-income [Income=5] are recorded with a higher WTP, supported by the negative estimates of other income groups, two of them showing statistical significance.

5.5 Results and Comparison of Planning Participation Mechanisms

5.5.1 The characteristics of public participation

Throughout the planning processes, several participation techniques including newsletters, roving exhibition, study website, public forum, briefing sessions, consultation meetings, etc. were used in the four cases. The affected residents, communities and non-governmental groups were given rights to speak out their demands and exchange ideas and considerations.

An inclusive participatory process is only as good as the context permits (Drazkiewicz et al., 2015). In other words, the context of the city is the basis of public participation. E.g. in HK, public participation in policy making has evolved from "government knows the best" to quasi-democratic polity and kept changing to more important role together with the social transitions of the city (Cheung, 2011; Hui & Au, 2016). Cities under electoral democracy such as Vienna, NYC and HK tend to be more active in participation activities than cities under democratic centralism such as Beijing. However, is the collective decision based on public participation always superior than the decision dominated by government? The effectiveness of participation will be further discussed.

5.5.2 The effectiveness of planning participation mechanism

Three approaches are used in previous studies to define participation effectiveness, those based on outcome, those based on process, and those incorporating both outcome and process goals (Conrad et al., 2011). In this Chapter, the participation processes and the evaluation of the planning outcome were demonstrated separately. The effectiveness of public participation could be compared based on the planning processes and outcomes in the four cases. In Table 5.26, the cases were ranked in three evaluation criteria. The rank of "The diversity of participation approaches" refers to the analysis in Section 5.2.5, "The objective performance"

of the layout is linked to green coverage rate (R_g), and "The subjective assessment" of the planning outcome is sourced from coverage satisfaction index (CSI) in Section 5.4.2.

Table 5.26 The comparison of participation process and UGS outcome in the four cases

Aspect of effectiveness	Evaluation criteria	HSK	HDN	Seestadt	Bushwick
Process	The diversity of participation approaches	3rd	Worst (4th)	Best (1st)	2nd
Outcome	The objective performance: R_g	2nd	3rd	Best	Worst
	The subjective assessment: CSI	Best	3rd	2nd	Worst

According to the ranking, none of the four cases get same rank in the three criteria, which suggests the effect of participation on process is inconsistent with the effect on outcome. The explanation of the inconsistence depends on the characteristics of each case.

A relatively good planning process generally relates to a good performance such as a greener layout with higher R_g; however, there are exceptions. The Seestadt, HSK and HDN show relatively consistent ranks on process and objective performance, which are 1^{st}-1^{st}, 3^{rd}-2^{nd}, and 4^{th}-3^{rd}. In contrast, the obvious downgrade is observed in case Bushwick, from 2^{nd} to worst. It can be indicated from the study of Bushwick that the increase of UGS is beyond the scope of the community plan and the capability of government. Throughout the participation process, activities mainly focus on the quality of existing UGS, e.g. the facilities, the edge management, the landscaping, etc. "Those (issues about how to build UGS) are political decisions...we can give the suggestions and we do. But that's not what really influences it (the decision)", said by the interviewee from NYC Parks. Previous research has highlighted that despite public participation, governments have final decision authority in the plan (Brown & Chin, 2013). However, the case of Bushwick further illustrated that the decision-making power may not be authorized to governmental departments but to where the money comes from. The outcome of the plan is limited to how much the government can afford.

Comparing the objective and subjective assessment, a high R_g is not related to high public satisfaction, which is probably because the standards of satisfaction set by the public are different among the cases. HDN and Bushwick show consistent ranks on process-objective performance of 3^{rd}-3^{rd} and 4^{th}-4^{th}. Seestadt and HSK swap their positions with 1^{st}-2^{nd} and 2^{nd}-1^{st} ranks. According to the questionnaire survey, people in Seestadt attach higher importance to UGS than other land uses, expressing strong desire to more UGS. As a result, it is more difficult for them to be satisfied due to the high reasonable UGS rate selected by the majority.

Another interesting phenomenon is about HDN, where the worst participation mechanism did not lead to the worst outcome. In some cases, the effect of participation may be challenged. As suggested by a previous study, citizen participation may be ineffective and wasteful under certain conditions, such as large population, trusted government, successful experiences in policy implementation without participation, etc. (Irvin & Stansbury, 2004).

Overall, the outcome of planning is more like a map of distribution of power, rather than just a land use layout. The more powerful a group of agents is, the more benefit it will obtain from the planning outcome and the distribution of land resources. In a political-economic perspective, the cooperative solution of the bargaining game corresponds to the maximization of a certain policy governance function, which is a weighted sum of the interest groups' power over the policy-making centre (Rausser et al., 2011). The effectiveness of the planning participation mechanism is determined by case-by-case factors and difficult to quantitatively evaluate.

5.5.3 The variation of social utility in and between cases

The utility functions of the public are differentiated between cases. According to Section 5.3.3, people think differently on the importance of different land uses. Respondents from Seestadt and Bushwick emphasis more on UGS, while those from HSK and HDN attaches importance to built-up uses such as Housing and Transportation. The differences were further highlighted by the importance values given to items of sustainable planning and the single-choice questions regarding UGS preference. Seestadt was surrounded by green thoughts, showing the highest UGS percentage and WTP. It is followed by Bushwick and HSK and HDN is the lowest.
The utility values are also differentiated between individuals. The results of the statistical analysis of the questionnaire are summarised in the table below.

Table 5.27 The comparison of statistically significant impact factors affecting UGS Percentage and WTP in the four cases

Variable	Value and Meaning	UGS Percentage as dependent				WTP as dependent				
		HSK	HDN	See stadt	Bush wick*	HSK	HDN	See stadt	Bush wick	All
Gender	1 - Male 2 - Female								+	
Age	1 - <20 years	+	+		+					+
	2 - 20~30 years				+					
	3 - 30~40 years	+	+		+					
	4 - 40~50 years	+	+							
	5 - >50 years									
Education	1 - Primary school and below	-	-			-				-
	2 - Middle school	-	-							

	3 - High school	-	-		+				
	4 - University and above								
Income level	1 - Extremely low income					-		-	-
	2 - Low income					-			-
	3 - Middle level							-	
	4 - High level	+	+			-			
	5 - Extremely high level								
Current satisfaction	1 - Very unsatisfied								
	2 - Unsatisfied	+	+		+				
	3 - Neutral								
	4 - Satisfied								
	5 - Very satisfied								

Note: The results of this column come from ANOVA, while others from Regression analysis.*

In most cases, varied preferences in UGS percentage and WTP were observed in different demographic groups. HSK and HDN share same impact factors in UGS percentage. Populations of senior citizens (age>50) and less educated people (below university level) generally do not desire for much UGS, while those with high income (4^{th} level) or those unsatisfied with current greenery landscape request for more UGS than other groups. As for Bushwick, only the factor of Age show influence on selected UGS percentage, in negative correlation.

The analysis reveals that the income level offers a highly effective means of describing the WTP. WTP of the Extremely high-income group is estimated as the most significant parameter in HDN, Bushwick and the full-sample models, meaning that the utility of the small group with extremely high income will be less influenced by the rising property price. Other factors of Gender, Age, Education level and Current satisfaction are found only to be influential in a single case or a couple of models, which could not be generalized.

What to be further discussed is the result of Seestadt questionnaire survey. Table 5.27. presents that none of the parameters have statistically significant impact in neither UGS percentage nor WTP. It seems that people in Seestadt perceive in inherently probabilistic manner, whatever the demographic features are. One possible explanation is the widespread of specific thoughts in the society, such as the importance of environment, advantages of closeness to nature and outdoor activities, and benefits of better living quality. A relevant theory is “social physics” which explores how good ideas spread to establish the social network and the flow of thoughts among individuals (Pentland, 2014).

5.5.4 Approaches for improving UGS provision in participation perspective

How the public aware the importance of UGS and how public preferences are considered in the decision-making of planning are influential to the planning outcome. People in Seestadt value the UGS more than other built-up land uses, which has not been observed in other three cases. Attentions should also be made to the differences in public preferences among democratic groups (Section 5.4.3) and the externalities of UGS provision to residents without high income. Regarding public satisfaction to green coverage rate (CSI), none of these cases reach to 1, which implies the current participation mechanism could not comprehensively integrate public preferences into land resource allocation and the planning outcome. Accordingly, to improve the public awareness of the living environment, to design incentive to avoid externalities, and to improve the effectiveness of planning participation are possible approaches for promoting UGS provision. Further considerations of applying these approaches are discussed and recommended in Chapter 7.

CHAPTER 6 MARKET MECHANISM AND UTILITIES OF MULTIPLE AGENTS

6.1 Summary of Chapter 6

The outcome of decision-making in land use planning is an equilibrium solution to a bargaining game among organized groups/agents, in a particular political-economic context (Rausser et al., 2011). Under the condition of a land market, the provision of land for UGS is competitive to the supply of land in other uses. How to ensure the compatible behaviour of multiple agents through balancing their utilities under market mechanisms is important to produce an expected planning outcome.

By applying the theory of mechanism design (MD) to the four cases, this Chapter aims to explore the relationship between land market mechanism and agents' utilities in the outcome of UGS layout. With agent-based CA modelling, market feedback of amenity value associated with public willingness to pay for adjacent UGS is captured to assess agents' utilities in designated land-use layouts. To identify the utility gaps between market outcome and maximum public welfare, two models focusing on existing planned UGS layout and optimized layout are simulated. The structure of this Chapter is shown in Figure 6.1.

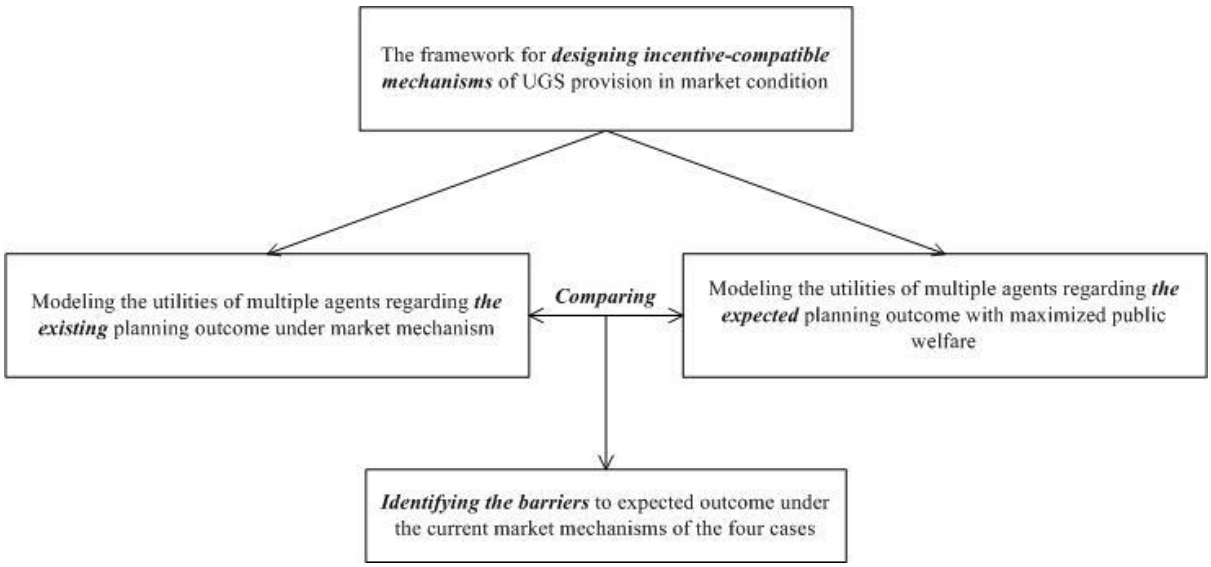


Figure 6.1 The diagram of the relationships between market mechanism and UGS provision

Note: The arrows with solid line "→" indicate the research flow of this chapter in terms of utilities of agents

In Section 6.2, the principles of the multi-agent CA model are proposed based on the theory of MD. Referring to the market outcome of planned UGS layouts in the four cases, utilities of

multiple agents are simulated in Section 6.3 using the proposal agent-based CA model. Section 6.4 demonstrates the expected outcome, in which the public could gain maximum welfare in terms of UGS provision. Changes in the utilities of multiple agents are dynamically monitored to identify the difference between expected outcomes and the ones produced under market mechanisms. Section 6.5 discusses the characteristics of the market mechanisms in the four cases, through comparing the barriers to improve public welfare under their current market mechanisms.

6.2 Principles for Designing the Mechanism

6.2.1 Applying MD theory to UGS provision

According to "the theoretical framework for applying MD theory to UGS provision" (Figure 2.5 in Section 2.6), the utility value of agents is the basis of planning outcome evaluation. Following the steps illustrated in the theoretical framework, agents' preferences and attributes should be firstly clarified, which are partly included in Chapter 4 and Chapter 5 and supplemented by some contents of the interviews. Secondly, agents' utilities associated with the outcome of UGS layout will be evaluated. Afterwards, utilities under the outcome the existing mechanism and the designated outcome with maximized social welfare will be calculated and compared. The utility differences between the actual and the expected UGS layout imply the constraints on maximizing public welfare. Compared with the actual UGS layout (market-oriented land use), the expected layout may lead to the reduction of utility ($U_i - U_i' < 0$), implying the potential barriers for optimizing UGS provision. Finally, the design of the mechanism is to avoid the utility reduction by providing incentives, until reaching the compatible status for all rational agents ($U_i \geq U_i'$ and $U_i \geq 0$).

6.2.2 Indexes related to the utility of agents

The proposed model for MD is an agent-based CA model, combining spatial features of land use with humane utility. In the environment of CA modelling, the land is divided to M*N grid. Variables associated with the feature of land use as well as the utility of agents are defined to represent the complex interactions among agents and between agents and their environment (Parker et al., 2003). To apply the model in a spatial context, the change in the land price according to the land use pattern is treated as a distance-decay function, which allows property closer to UGS to be more influenced by the UGS up to some distance (Ham et al., 2012). If the cell (i,j) is located within the catchment area ($d_{i,j} < r$), it will show the premium reducing according to the distance, and if the cell is located beyond the catchment area, the initial price

index will continue to hold. The UGS, catchment area, catchment radius (r), and distance ($d_{i,j}$) are spatially illustrated in Figure 6.2.

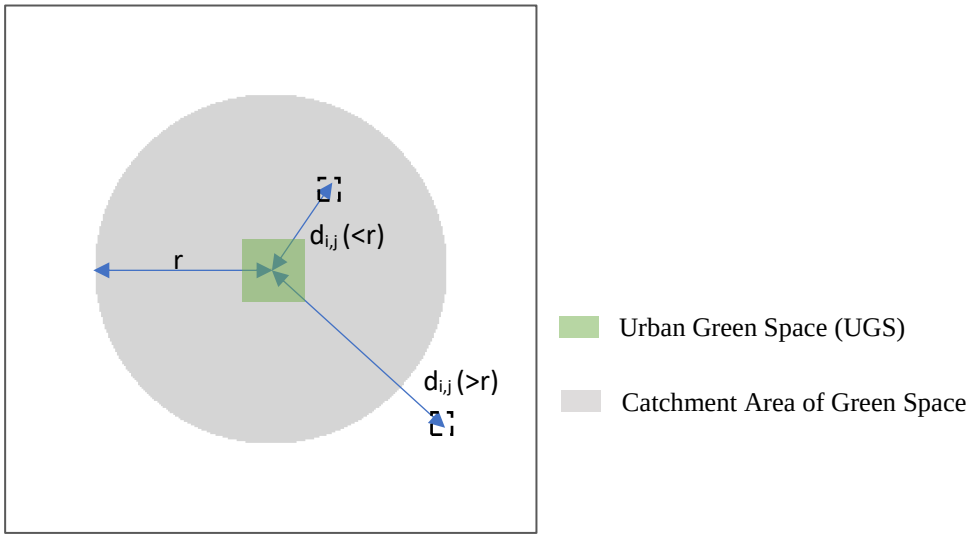


Figure 6.2 Spatial illustration of green space, catchment area, catchment radius (r), and distance ($d_{i,j}$)

The variables are categorized in four aspects of Pattern, Distance, Area and Price, referring to Table 6.1.

Table 6.1 Variables related to the land use patterns and the utility of agents

Aspect	Variables	Meaning
Pattern	m	The number of rows in the land use pattern
	n	The number of columns in the land use pattern
	N_t	The total amount of cells in the land use pattern (m*n)
	N_b	The number of built-up cells in the land use pattern
Distance	$d_{i,j}$	The distance from land cell i,j to the nearest Open Space (OS)
	r	The radius of OS catchment area within walkable distance
Area	A_g	The area of UGS (OS included)
	A_b	The area of buildable land
	A_t	The total area of the piece of land ($A_t = A_g + A_b$)
	A_a	The built-up area with accessible OS (where $d_{i,j} < r$)
Price	P_l	The average land price in all-developed pattern
	P_h	The average house price in all-developed pattern
	P_r	The price premium rate of OS (10% in this model)

To link the spatial feature of land use with the utility of agent, indexes related to the interest of agents are designed. In condition of public landownership, agents of Government, Developer, Public and Environmentalist are included, while under private landownership, one more agent of private land owner is added since government no longer owns the land. The relationships between the preference and the utility of agents associated with indexes are illustrated in Table 6.2.

Table 6.2 The relationships between the preference and the utility of agents associated with indexes[#]

Preference	Index	Government		Landowner (private)	Developer	Public	Environmentalist
		(public)	(private)				
I want more buildable/saleable land	Buildable Land Index (BLI)	+	+	+	+		
I want higher land price	Land Price Index (LPI)			+	-		
I want more land sale income of the piece of land	Land Sale Index (LSI)	+		+			
I want higher house price	House Price Index (HPI)				+	-	
I want more taxation payment	Taxation Payment Index (TPI)	+	+			-	
I want more conservation payment	Conservation Payment Index (CPI)		-	+			
I want more UGS in this area	Coverage Satisfaction Index (CSI)					+	+
I want accessible GS	Accessibility Satisfaction Index (ASI)					+	
I want the environment to be protected	Environment Protection Index (EPI)						+

[#]Notes: the mark of "+" means positive relation and the mark of "-" means negative relation.

According to the table above, the utility of each agent is connected with the index. E.g. Governments under public land ownership prefer more buildable land (higher BLI), more land sale income (higher LSI), and more taxation payment (higher TPI). As a result, their utility will be improved if the values of these three indexes increase. The formula of each index will be further explained.

Buildable Land Index (BLI)

In a land use pattern, land planned for built-up uses rather than UGS is defined as buildable land, including commercial land, residential land, industrial land, as well as land for transportation, facility and infrastructure. Buildable Land Index (BLI) is to show the percentage of built-up area in a land use pattern, which is defined as:

$$BLI = A_b / A_t$$

where A_b represents the area of buildable land for sale, and A_t represents the total area of the land in the project.

Among the built-up land categories, some could be sold in land market, such as land for commercial, residential and industrial uses. Assumed that the proportion of saleable land in buildable land is constant, the index of saleable land equals to BLI.

Land Price Index (LPI)

Land Price Index (LPI) implies the relative land price of the cells with the provision of OS. In the model the price premium (P_r) associated with the provision of OS is assigned as 10% for all cases. For each cell

$$LPI_{i,j} = \begin{cases} P_l \text{ ; if } d_{i,j} \geq r \\ P_l * (1 + P_r) \quad \text{; if } d_{i,j} < r \end{cases}$$

$LPI_{i,j}$ represents the price index of cell i,j, P_r represents the price premium, and P_a represents the average price when all land is developed.

$$LPI = (\sum_{i=1,j=1}^{m,n} LPI_{i,j}) / N_b$$

The LPI of a land use pattern equals to the sum of $LPI_{i,j}$ of all cells dividing the number of buildable cells in this pattern.

Land Sale Index (LSI)

Given a piece of buildable land, all land cells are developed at the start point and sold at the average price P_a, LSI is calculated using Formula:

$$LSI = LPI * BLI$$

In the simulation, UGS will be designed, e.g. inserting a park or green space into the construction land, and both the value of LPI and BLI will be changed. LSI represent the integrated effect of these two indexes, which will be dynamically monitored in the simulation process.

House Price Index (HPI)

In case the index is applied in land-plot level with large area, only binary status (whether inside outside the OS catchment area) will be considered, such as LPI. However, for index in building level with relatively small land area, the linear distance-decay function (different impact inside the OS catchment area) will be used. House Price Index (HPI) of each cell is defined as:

$$HPI_{i,j} = \begin{cases} P_h \quad ; \text{if } d_{i,j} \geq r \\ P_h + 2P_r * (1 - d_{i,j}/r) \quad ; \text{if } d_{i,j} < r \end{cases}$$

$HPI_{i,j}$ means the house price index of each cell when OS is provided. P_h represents the average house price in all-developed pattern. P_r represents the premium rate on house sale price due to the OS provision. $d_{i,j}$ is the distance from land cell i,j to the nearest OS, and r is the radius of OS catchment area within walkable distance.

$$HPI = (\sum_{i=1,j=1}^{m,n} HPI_{i,j}) / N_b$$

Similar with LPI, the HPI of a land use pattern equals to the sum of $HPI_{i,j}$ of all cells dividing the number of buildable cells in this pattern.

Taxation Payment Index (TPI)

Taxation Payment Index (TPI) values differently for individual house buyer and the government. For public who buy the property, the taxation payment is proportionally related to the house price, while for government the taxation income is a sum of the tax payment of all the property in developed area. Therefore, the formula of TPI are assigned as,

$$TPI\text{-individual} = HPI * BLI$$

and

$$TPI\text{-government} = HPI.$$

Conservation Payment Index (CPI)

Conservation Payment Index (CPI) is related to the purchase of land for UGS under private landownership. It is assumed government will pay the private land owners to restrict the development of their land and conserve it for GS. The relative change of CPI is associated with the proportion of land to be conserved.

$$CPI = A_g / A_t$$

A_g is the area of GS, and A_t is the total area of the land in the development project. The value CPI is equals to the green coverage rate (R_g).

Coverage Satisfaction Index (CSI)

Coverage Satisfaction Index (CSI) implies public satisfaction with the quantity of UGS provided. It is the only index with different formulas for the four cases. The concept and the calculation of CSI have been demonstrated in Section 5.4.1 and Section 5.4.2 of Chapter 5.

Accessibility Satisfaction Index (ASI)

The accessibility is an OS-related index, evaluated by the percentage of land areas within the walkable scope of any OS.

$$ASI = A_a / A_t$$

A_a means the built-up area with accessible UGS (where $d_{i,j} < r$), and A_t means the total area of the piece of land. In the model, the walking distance (r) is designated as 500m. If there are more than one GS, only the distance to the nearest one will be counted.

Environment Protection Index (EPI)

Environment Protection Index (EPI) is to show how well the environment regarding this piece of land is protected. The heterogeneous ecological value of land was observed in case of HSK. According to the Community Engagement Report[29], some environmental groups and the Advisory Council on the Environment have proposed to protect the existing areas of ecological importance, such as the egretry within the NDA, and to retain the exiting fly path with building setback distance from the egretry. Theoretically, the land with higher ecological value is protected, the larger area of land is conserved, the higher the value of EPI will be. However, in the other three cases, land resource is considered homogeneous since no difference in ecological and environmental value has been pointed out. Therefore, this index will not be evaluated in the simulation.

6.2.3 Maximizing expected public welfare

The Public are the end users of UGS. Two indexes of CSI and ASI are positively related to public utility, while two indexes of HPI and TPI are negatively related to utility of individuals who buy the property. The object of the designed mechanism is to achieve the outcome of UGS

[29] The Government of the Hong Kong Special Administrative Region. The HSK NDA Study - Community Engagement Report. www.hsknda.gov.hk/#?framePage='http://www.hsknda.gov.hk/big5/community-engagement3.html'

layout with maximum public welfare ($\max \sum_{i=1}^{N} U_i(\theta_i)$ for all i∈P). Correspondingly, the expected value of the indexes should be: maximum ASI, maximum CSI, and no increase in HPI and TPI-individual.

Assuming the index values under current mechanism are HPI' and TPI-individual', the performance of the expected UGS pattern should be performed as:

$$\begin{cases} CSI = 1 \\ ASI = 1 \\ HPI \leq HPI' \\ TPI\text{-individual} \geq TPI\text{- individual}' \end{cases}$$

in which the maximum public welfare will be achieved.

When achieving the outcome with maximum public welfare, the mechanism may be incentive incompatible or infeasible to rational individuals. The former is related to the reduction of utility where $U_i < U_i'$, and the later implies the reduction may lead to benefit loss of the agent where $U_i < 0$. The design of a mechanism is to ensure their utilities will not be adversely influenced by the outcome, through modifying the utility function of agents ($u_i = f(x, \theta_i, w_i, t_i)$).

6.3 The Utility Values of the UGS Layout as Market Outcome

6.3.1 The framework of Agent-based CA model

Based on Table 6.2, agents' utilities are represented by the values of the indexes, which are associated with the feature of UGS layout. To measure the utilities of different agents under a designated land use pattern, an agent-based CA model is established.

In case of HSK, HDN and Seestadt with public land ownership, four agents are considered in the model, namely Government (also known as the land owner of the public land), Public, Developer (groups with interests of development), and ENGO (groups with interests of environment). For each land use pattern, e.g. UGS Layout (a) or UGS Layout (b), the values of the indexes will be calculated, according to which the utilities of agents are measured. As the pattern changes, so will the values of indexes and the utilities. The framework of the model is illustrated in Figure 6.3.

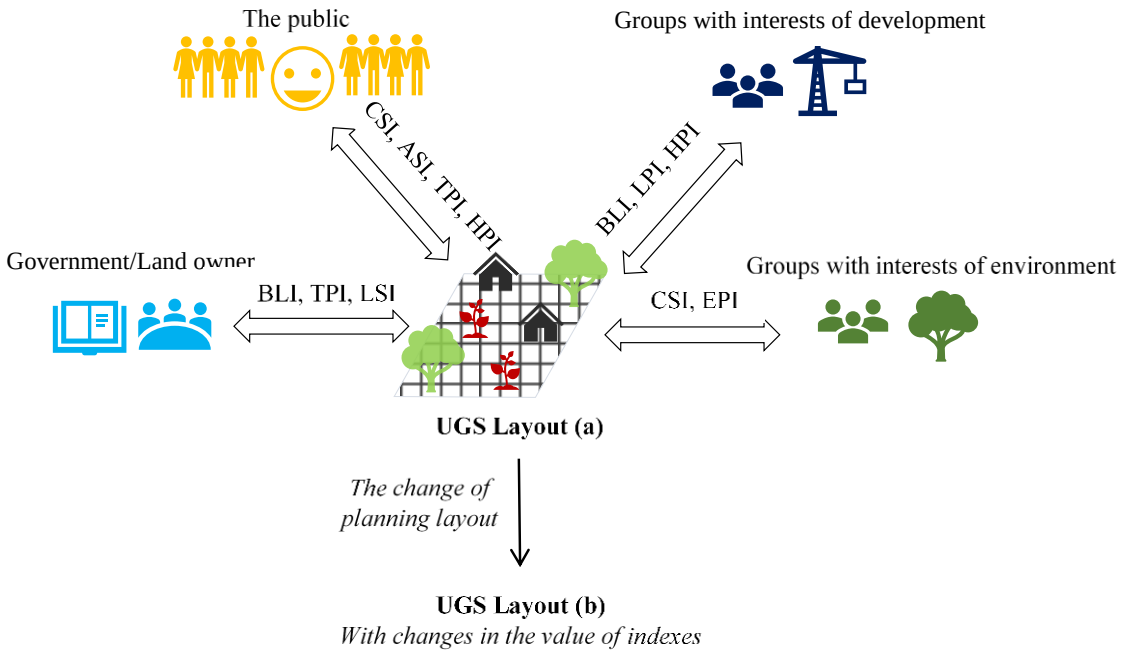


Figure 6.3 The conceptual framework of the agent-based cellular landscape model (public landownership)

Under the private landownership (case of Bushwick), private Land owner is another agent group to be considered in the model. Correspondingly, indexes related to the Government utility change from BLI, TPI and LSI to BLI, TPI and CPI. The framework of the model refers to Figure 6.4.

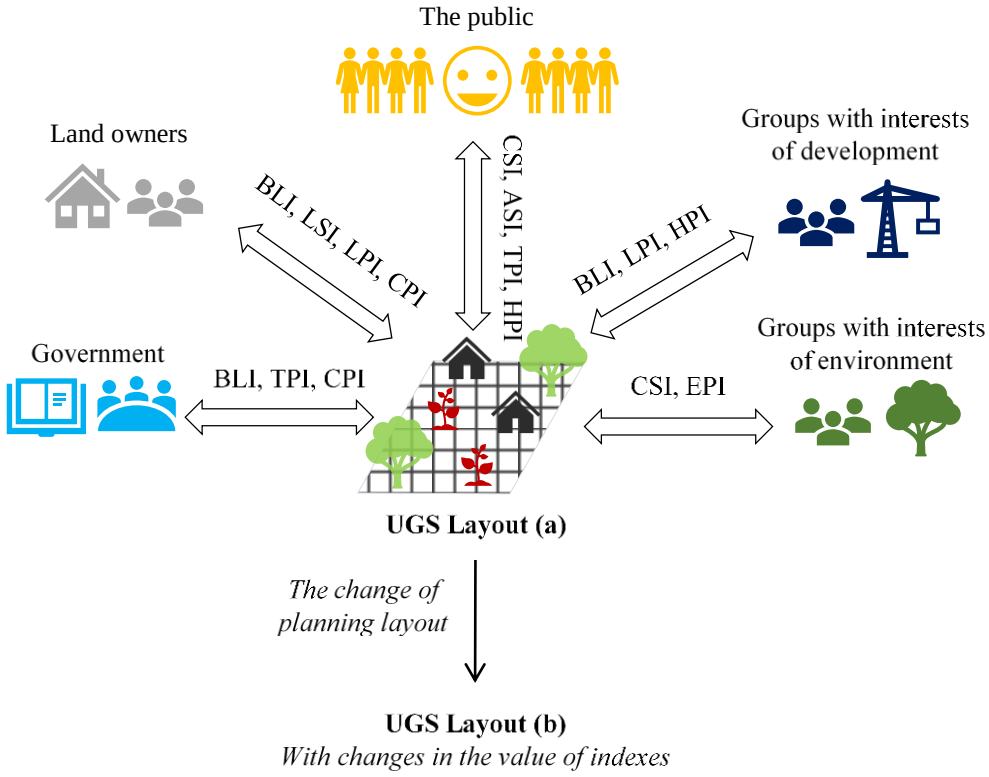


Figure 6.4 The conceptual framework of the agent-based cellular landscape model (private landownership)

The model aims to show how the utilities of multiple agents change in different UGS layouts, by monitoring the value of related indexes. The calculation of the indexes refers to the formulas in Section 6.2.2. However, regarding the variation in the mechanisms of the four cases, the model will be slightly modified to adapt the characteristics of individual cases. For example, to calculate CSI in each case, the parameters of R_a, R_b, G_s refer to Table 5.13 in Section 5.4.2. The land use patterns as market outcome refer to the planning UGS layouts in the four cases.

6.3.2 Data sources and data processing

To get the spatial data of the UGS layout of each case, maps of the development areas of four cases were collected. The maps were then imported and rectified in ArcGIS 10.2, using the function of Georeferencing. Projected Coordinate Systems were applied to facilitate the calculation of distance and area. Information of data sources and coordinate systems are listed in the following table.

Table 6.3 The basic information of the vector data of the four cases

Case	Base Map (Vector Data)	Data Source of Base Map	Projected Coordinate System (Layers)
HSK	Hong Kong Digital Topographic Map: B5000	The Hong Kong Digital Maps (produced by Lands Department), Pao Yue-kong Library, The Hong Kong Polytechnic University (https://www.lib.polyu.edu.hk/digital-map/b5000.php)	WGS_1984_UTM_Zone_49N
HDN	Beijing Boundary Map	Online Free Open Source Data (http://www.arcgis.com/home/item.html?id=17e32c292bdb40d89cbe80752047262e)	WGS_1984_UTM_Zone_50N
Seestadt	Vienna Street Map	Website of Vienna Open Government Data (http://data.wien.gv.at/daten/geo/ows?service=WFS&request=GetFeature&version=1.1.0&typeName=ogdwien:STRASSENGRAPHOGD&srsName=EPSG:4326&outputFormat=shape-zip)	WGS_1984_UTM_Zone_33N

Bushwick	New York Community Districts; Parks Properties	Website of NYC Open Data (https://data.cityofnewyork.us/dataset/Community-Districts-Water-Areas-Included-/mzpm-a6vd) (https://data.cityofnewyork.us/City-Government/Parks-Properties/rjaj-zgq7)	WGS_1984_UTM _Zone_18N

The maps contain vector data of the studied areas; however, raster data is required for agent-based CA modelling. The software of Netlogo[30], which provides a multi-agent programmable modelling environment, is used for modelling. To obtain the data in format of ASCII for Netlogo, the maps were processed in four steps of Feature Creation → Feature Editing → Data Conversion → Data Export. For each case, layers of "Boundary", "Open Space", "Other Green Space", and "Built-up Land" were vectorized by creating polygons of different land use in ArcGIS, based on the planning UGS pattern and the base map. The layers of "Open Space", "Green Space", and "Built-up Land" were merged as one feature with different land-use properties. The created feature was then converted to raster data within the boundary (the layer of "Boundary" as Mask), while the cell value represented the property of land use as follows: 1= Built-up use, 2 = Open Space, and 3 = Other Green Space (open space excluded). The cell size is designed as 10m*10m, since it is approaching to the area of land plot (homogeneous feature within a cell), easy to calculate land area (100m^2 of each cell) and convenient to transfer distance data (10 meters/unit). Afterwards, the raster data was exported in ASCII format (. asc) for Netlogo. The basic information of the raster and ASCII data of the four cases are shown in Table 6.4.

Table 6.4 The basic information of the raster and ASCII data of the four cases

Case	Columns and Rows	Cell Size	Extent
HSK	334, 498	10m * 10m	Top: 2487753.018494 m Left: 805773.168091 m Right: 809114.407104 m Bottom: 2482769.767700 m
HDN	400, 345	10m * 10m	Top: 4438117.053639 m Left: 433367.522191 m Right: 437362.909914 m Bottom: 4434671.590723 m
Seestadt	195, 189	10m * 10m	Top: 5343592.681630 m Left: 610921.208857 m Right: 612874.436881 m Bottom: 5341700.801979 m

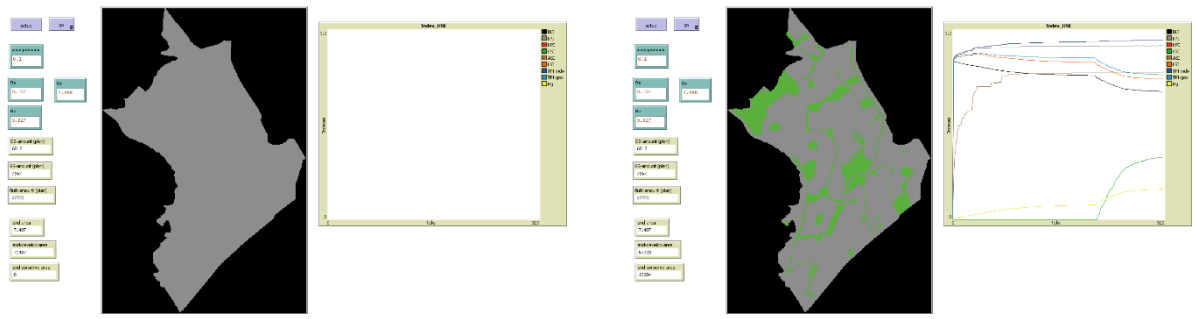
[30] Wilensky, U. (1999). NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Bushwick	343, 333	10m * 10m	Left: 589387.288520 m	Top: 4507056.944927 m Bottom: 4503725.918964 m	Right: 592820.757806 m

The ASCII data was then imported in Netlogo for modelling.

6.3.3 Model simulation and results

The simulation started from a none UGS scenario and was run with the area of UGS expanding until it forms the designated land use pattern. To set up, the initial state of the model is a pattern in which all the cells developed without any UGS. In simulation, the green spaces are dynamically increased in small incremental patches. Cells with land use of "2 = Open Space" will be converted from developed status to conserved status in random order, followed by the conversion of "3 = Other Green Space" cells. In the meanwhile, the values of the indexes are dynamically calculated and monitored. The simulation will stop when the planned UGS layout is formed. Taken HSK as an example, the interfaces of the initial state and the final states of the model are as follows.

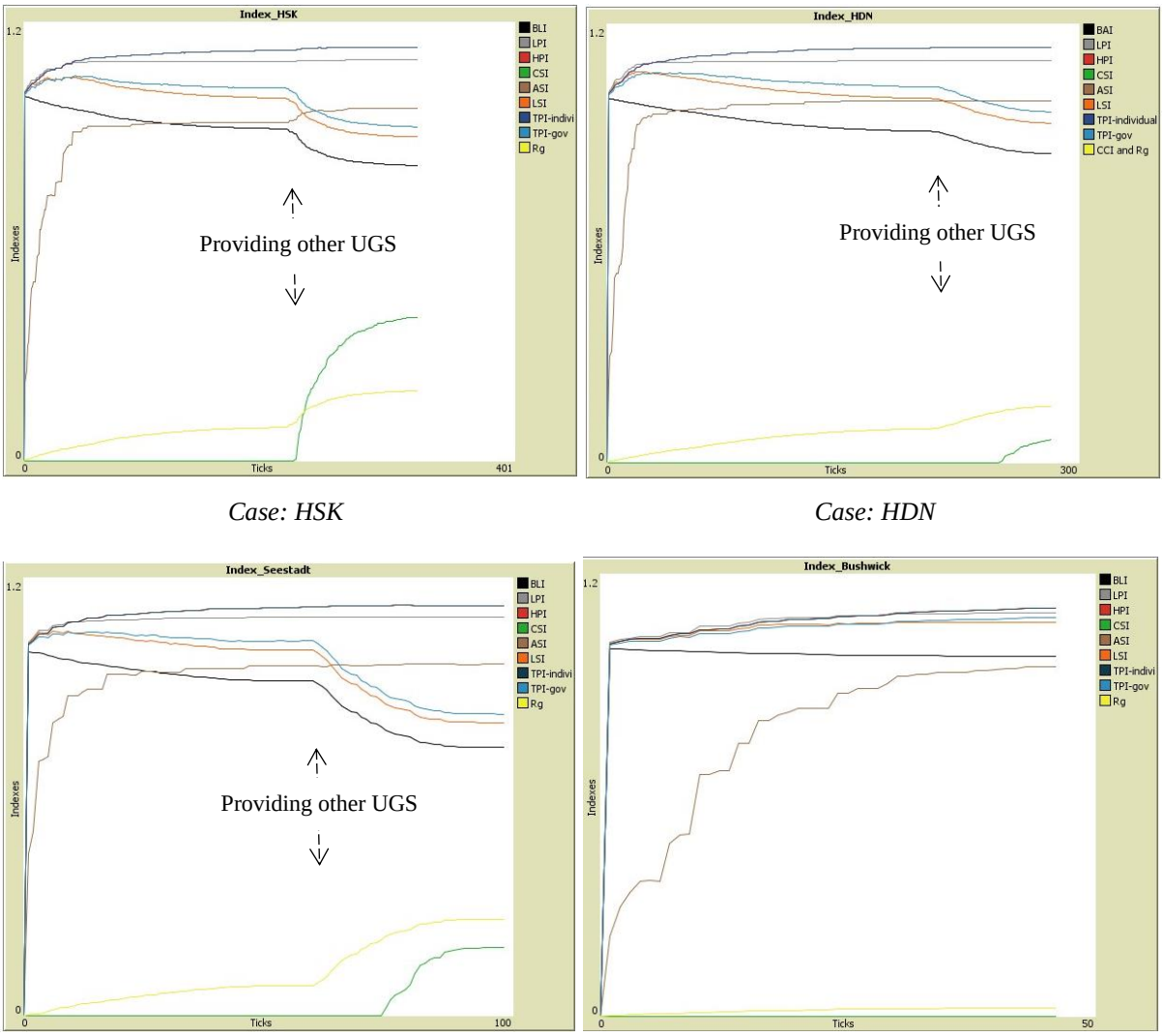


(a) Initial layout without UGS (b) Final layout with planned UGS

Figure 6.5 the interfaces of the initial layout (a) and the final layout (b) of the model

Note: The interface consists of three parts. (1) buttons, input boxes and monitor boxes in the left; (2) the simulation world in the middle with cells beyond the boundary in black; and (3) the plot of indexes in the right.

The values of the indexes were plotted, including BIL, LPI, HPI, CSI, ASI, LSI, TPI-individual, TPI-government, and R_g. The horizontal axis "ticks" is the real-time value of the tick counter, which implies how many times the procedure of "go" has been repeated. For each "go" loop, a piece of UGS will be conserved, with the tick counter advanced by one and all plots updated. The results of the four cases are illustrated in Figure 6.6.



Case: HSK *Case: HDN*

Case: Seestadt *Case: Bushwick*

Figure 6.6 The result of the dynamic plots of the indexes in the simulation of the four cases

The four cases were simulated separately. The values of the indexes change as the increase of OS and then other UGS. The turning points from OS provision to the other UGS were marked in the figures. In Bushwick, all the UGSs in the land use pattern are classified as OS. The final values of the indexes as well as the changes from the initial the status are presented in the table below.

Table 6.5 The result of the indexes regarding the planned UGS layouts in the four cases (market condition)

Index	BLI	LPI	HPI	ASI	CSI	LSI	TPI-indiv	TPI-gov	R_g
Initial value (Scenario A)	1	1	1	0	0	1	1	1	0

Final value in the four cases (Scenario B)									
HSK	0.808	1.096	1.131	0.964	0.393	0.886	1.131	0.914	19.2%
HDN	0.845	0.099	1.135	0.990	0.063	0.929	1.135	0.960	15.5%
Seestadt	0.735	0.092	1.124	0.963	0.188	0.803	1.124	0.827	26.5%
Bushwick	0.977	0.095	1.108	0.949	0.000	1.070	1.108	1.082	2.3%
Change from the initial to final value (B - A)									
HSK	-0.192	0.096	0.131	0.393	0.964	-0.114	0.131	-0.086	19.2%
HDN	-0.155	-0.901	0.135	0.063	0.990	-0.071	0.135	-0.040	15.5%
Seestadt	-0.265	-0.908	0.124	0.188	0.963	-0.197	0.124	-0.173	26.5%
Bushwick	-0.023	-0.905	0.108	0.000	0.949	0.070	0.108	0.082	2.3%

Table 6.5 illustrates that most of the indexes increased in the planned UGS pattern compared with the initial all-developed pattern, except for BIL and LSI and TPI-gov in some cases. BIL decreases by 0.16-0.27 in cases of HDN, HSK and Seestadt, combined with the decrease of LSI and TPI-gov. In the land use layout of Bushwick, BLI slightly declines 0.02, together with the increase of LSI and TPI-gov by 0.07 and 0.08 respectively. In corresponding to the scale of UGS, CSI of the three cases rise evidently (0.06~0.39), but it reminds 0 in Bushwick where R_g is merely 2.3%. Weak differences are observed in ASI between the four patterns. With 10% land price premium set in the model, the provision of UGS can result in a relative increase in the values of LPI, HPI, and TPI-indiv.

6.3.4 Model validation

To validate the proposed agent-based CA model, the indexes which are associated with spatial properties were alternatively calculated with ArcGIS. Layers of “Boundary”, “Open Space” and “Other Green Space” were the input source data as feature classes. The raster data of “Distance to OS” within boundary was created using the function of “Spatial Analyst → Distance → Euclidean Distance”, and then clipped by “Other Green Space” layer. Based on the attributes of the raster data, the indexes were calculated according to the formulas established in Section 6.2.2.

The values of the indexes were compared with the results (final status) from Netlogo. Taken the case of HSK as an example, table 6.6 presents the results of the two methods as well as their differences.

Table 6.6 The comparison of the final value of spatial indexes from ArcGIS and Netlogo (Case: HSK)

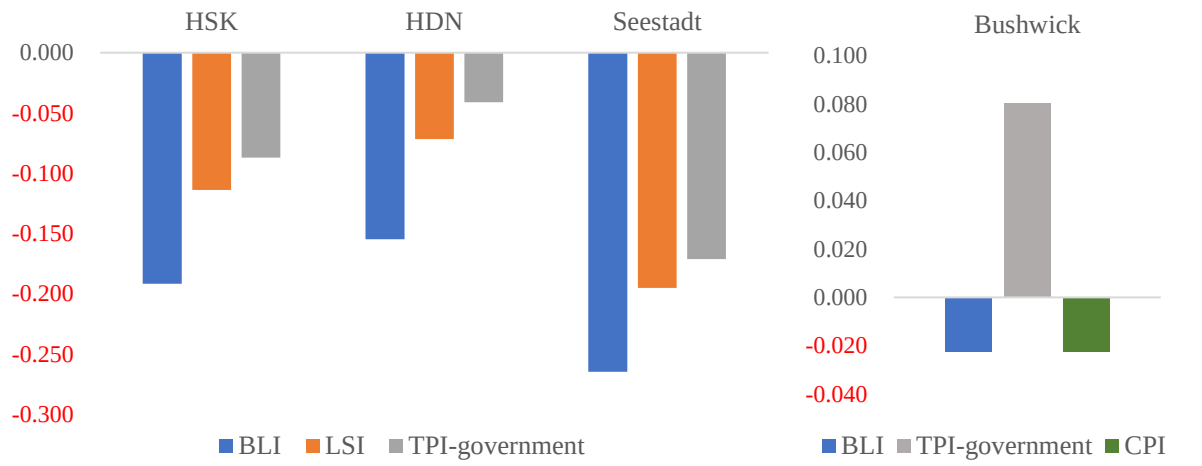
Index	BLI	LPI	HPI	ASI	LSI	TPI-indiv	TPI-gov	R_g
ArcGIS	0.808	1.097	1.130	0.966	0.886	1.130	0.913	19.2%
Netlogo	0.808	1.096	1.131	0.964	0.886	1.131	0.914	19.2%
Relative difference[#]	0.000	-0.001	0.001	-0.002	0.000	0.001	0.001	0.000

[#]*Note: Taken the result from ArcGIS and Netlogo as a and b respectively, the relative difference is measured by (b-a)/a.*

According to Table 6.6, the deviations in the final values between the ArcGIS calculation and the Netlogo simulation were less than 0.2% for all indexes, indicating the credibility of the result (final status) from Netlogo and the dynamic simulation. The remaining differences may be related to the difference in distance calculations of ArcGIS and Netlogo. For example, to improve the operation speed on Netlogo, the OS was increased by square/neighbourhood rather by single cell. When calculating distance, the centre the square is the destination. Therefore, in Netlogo the shortest distance is to the neighbourhood at the edge of OS, while in ArcGIS the shortest distance is to the cell at the edge of OS. However, the differences are slight and acceptable. Although there are some approximations in applying the model to real cases, this model shows the possibility in quantifying the benefits of related stakeholders through the indexes.

6.3.5 The utility of agents in four cases

As displayed in “Table 6.2 The relationships between the preference and the utility of agents associated with indexes”, the utility of each agent is revealed by several indexes. The correlations between some indexes and utility are positive, while some others are not. The utilities of agents are represented by the relevant indexes and their relationship. The change of government utility is depicted in Fig 6.7.



(a) Cases under public land ownership *(b) Case under private land ownership*

Figure 6.7 The changes of indexes related to the utility of government (B-A)

In the scope of public UGS provision, governments are the suppliers in the four cases. However, in condition of public land ownership (cases of HSK, HDN and Seestadt), governments are also the land owners before the development, while under private land ownership (case of Bushwick) governments need to gain land rights from private landowners and convert them to public uses for UGS. Indicated by Fig 6.7, the utility of government reduced apparently in case of HSK, HDN and Seestadt, indicated by the negative value of BLI, LSI, and TPI-government. The government in Bushwick will obtain higher taxation income due to the small amount of UGS, however they need to bear the conservation payment for purchasing land from private land owners for UGS supply.

Referring to the group of private land owners, the UGS in Bushwick brought more economic benefit due to increasing LPI, LSI and CPI. Their economic utilities have not been lost due to the provision of UGS, even though the area of buildable land is slightly reduced,

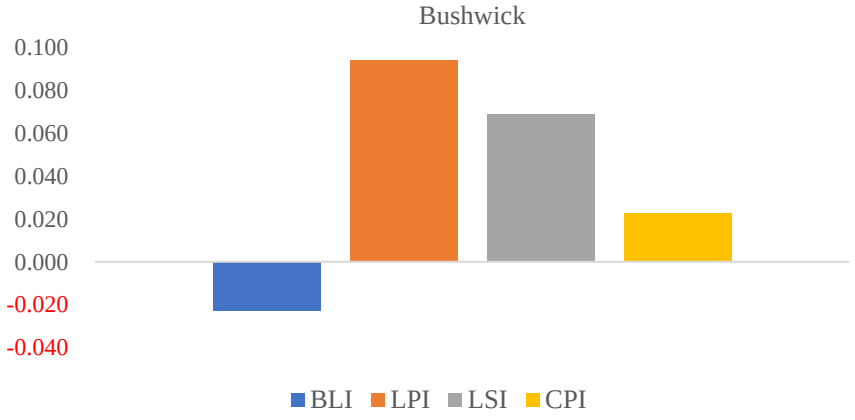


Figure 6.8 The changes of indexes related to the utility of private land owners

The developers in the four cases confront similar situations. Either under public or private land ownership, developers need to buy land from land owners, undertake the construction work and sell the property. The provision of UGS resulted in negative effects of less land to develop (BLI) and more cost for buying land (LPI), and positive return from higher house sale price (HPI), shown in Figure 6.8.

What the public benefited from the pattern is the improvement of UGS accessibility and green coverage. All the four cases performed well in accessibility according to the relatively high value of ASI. The analysis of CSI refers to Section 5.4.2. However, people who live close to the UGS, due to the amenity value, will bear the rising housing price and property tax.

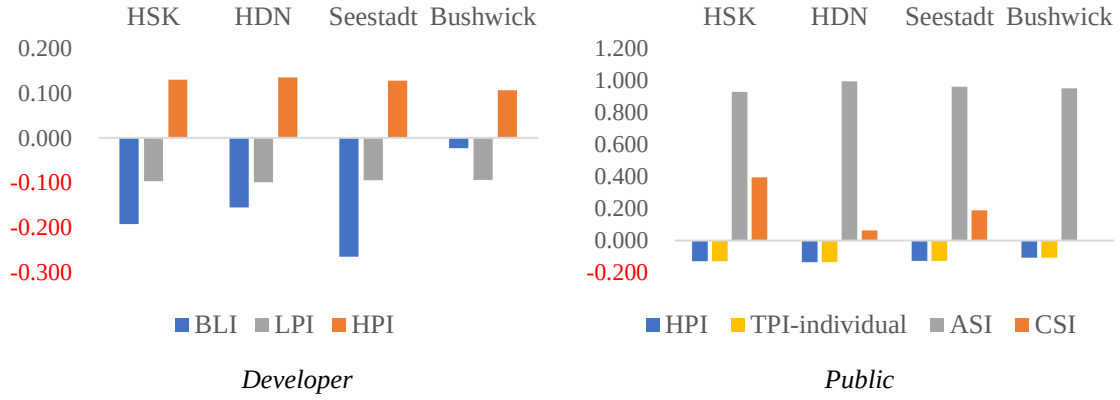


Figure 6.9 The changes of indexes related to the utility of developer and public (B-A)

The results suggest the utilities of agents in the four cases will change from the all-developed land use pattern. In general, government is the agent who give most to form the UGS layout, especially for cases with public land ownership while public benefit most, especially for those who enjoy the UGS benefit but do not need to bear the rising housing price and taxation. The utility of developers is not much affected by UGS provision, since the observed negative and positive effects can offset each other (although the model could not tell how much to be offset). Private landowners are likely to earn benefit with relatively less UGS, such as Bushwick.

6.4 Optimizing the Provision of UGS for Maximum Public Welfare

6.4.1 Principles of UGS layout with maximum public welfare

When optimizing the UGS layout to achieve the expected outcome with maximum public welfare, the objective function of the mechanism design is $\max \sum_{i=1}^{N} U_i(\theta_i)$ for all i∈P. ASI and CSI are two indexes representing the utility of public. In the results of simulation in Section 6.3.3, the values of ASI and CSI are less than 1 in the four cases, implying the public welfare did not reach the maximum level. Therefore, in the optimization model, two principles are established as follows:

(a) ASI=1, which implies all the UGS are accessible with walking distance (<500m), and the value of ASI equals to 1;

(b) CSI=1, which means the majority (not less than half) people are satisfied with the coverage rate of UGS in the study area.

Therefore, the final status of the optimized UGS layout would be ASI=1 and CSI=1, corresponding to the land use pattern of each case.

6.4.2 Model simulation and result

Based on the model demonstrated in Section 6.3.3, the optimization model is established by increasing the value of ASI and CSI, while the changes of other indexes are monitored in the same rules. The procedure of the optimization model is illustrated in Fig 6.10.

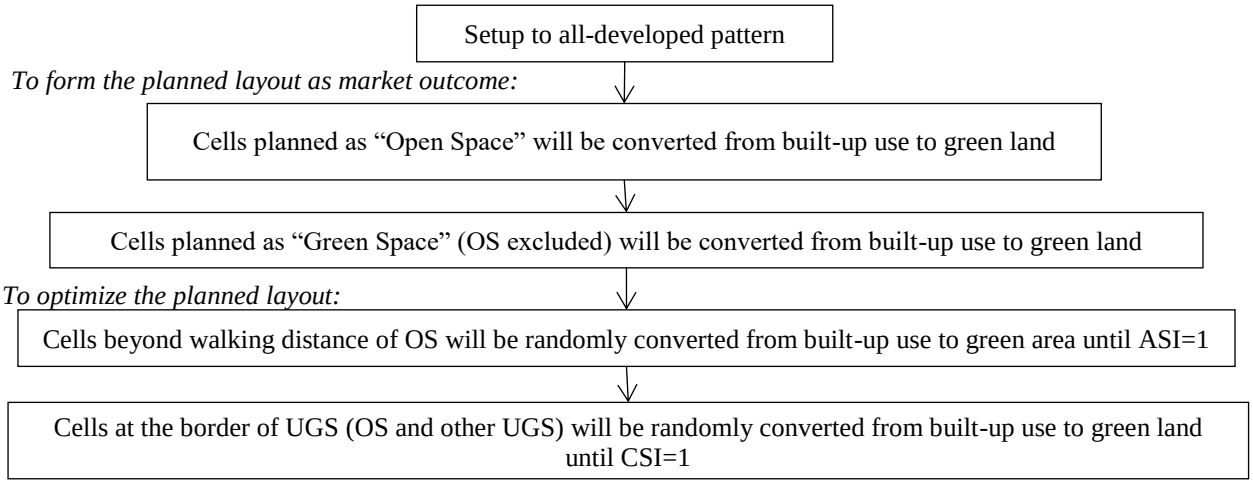
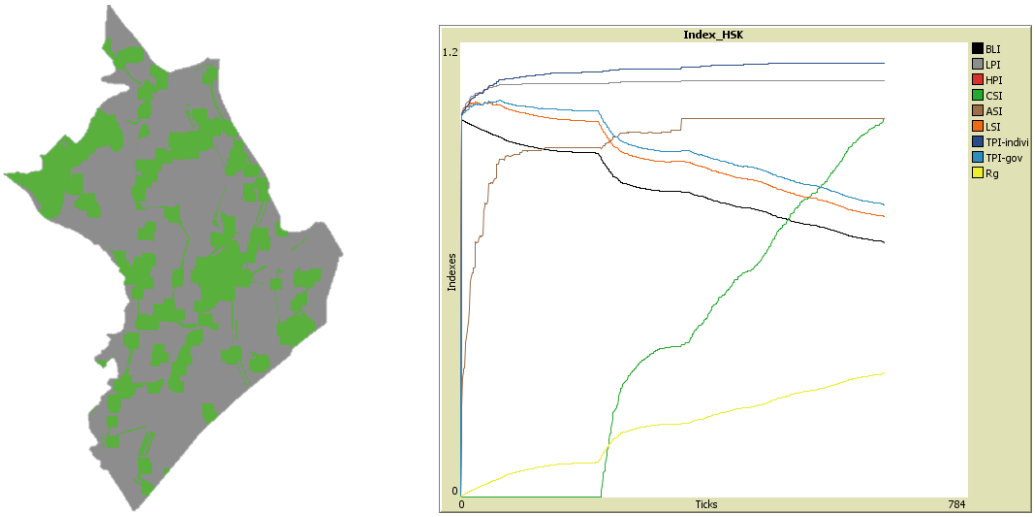
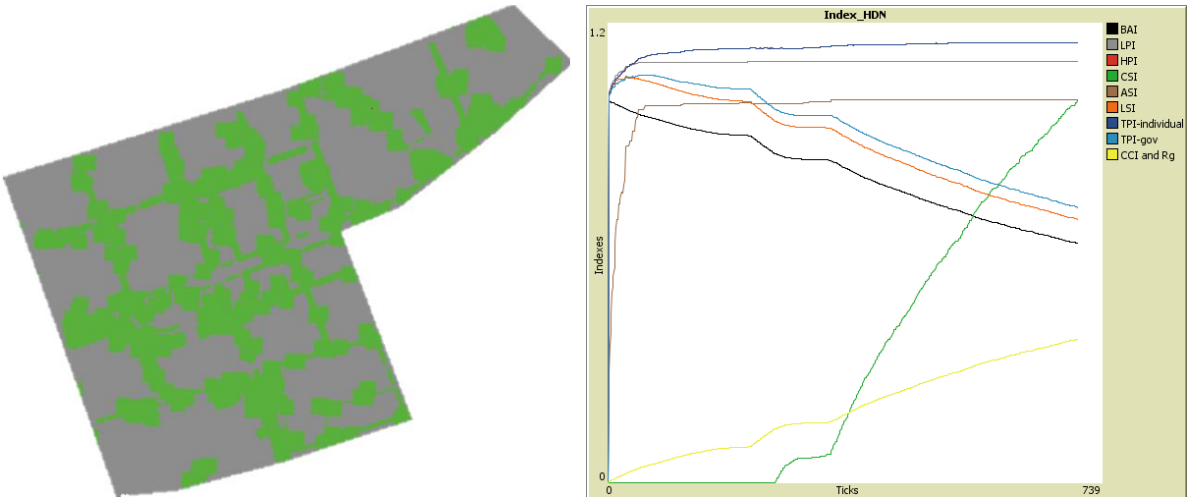


Figure 6.10 The procedure of the simulation to form the optimized UGS layout

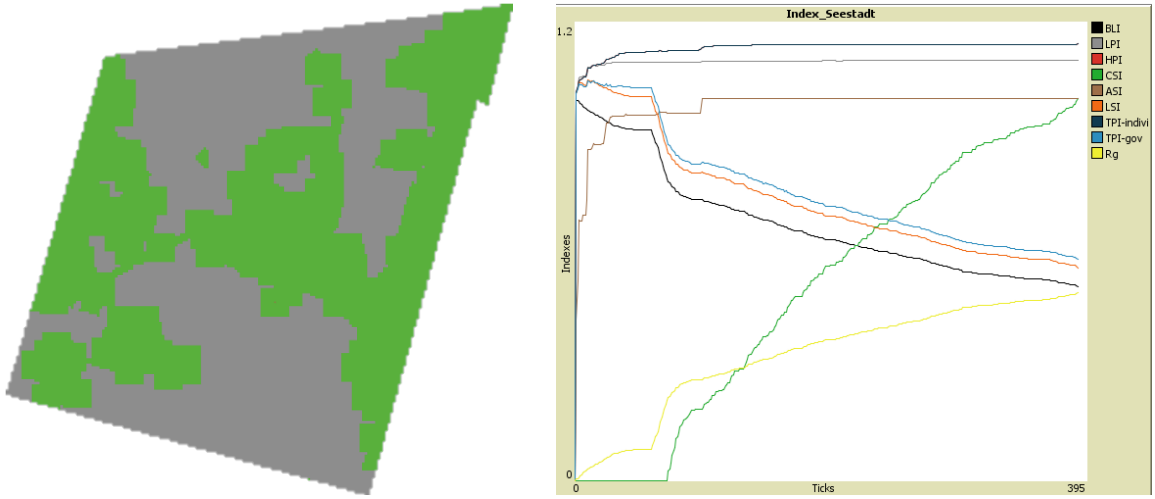
The outcome of the optimized UGS patterns and the plots of the indexes are expressed by case, through the charts in Figure 6.11.



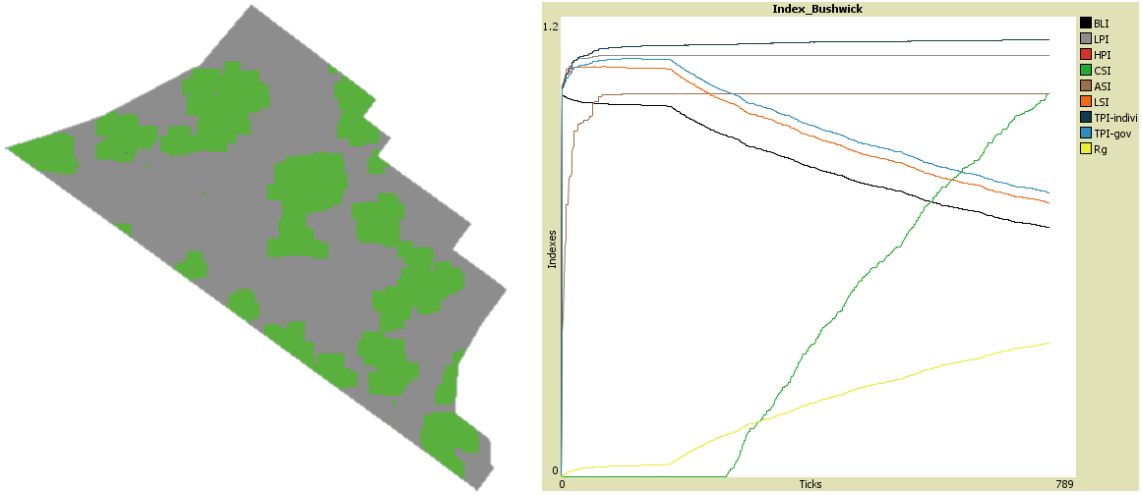
(a) *Case HSK*



(b) *Case HDN*



(c) *Case Seestadt*



(d) *Case Bushwick*

Figure 6.11 The result of the optimized UGS patterns (left column) and the plots of indexes (right column) in the four cases

The UGS in the four cases is projected to increase from the planned layout to the optimized layout by improving the accessibility and expanding the area. By comparing the optimized UGS layouts (Fig 6.11) with the planned layouts (Fig 3.2), it is easy to distinguish the greener environment created by the optimized land use patterns. According to the plots in Fig 6.11, the first principle (ASI=1) is soon reached after the simulation; however, to meet the second principle (CSI=1), more loops are simulated with remarkable changes in UGS layout. Table 6.7 shows the final values of the indexes in the optimized pattern.

Table 6.7 The result of the indexes regarding the optimized UGS layouts in the four cases (public welfare maximization)

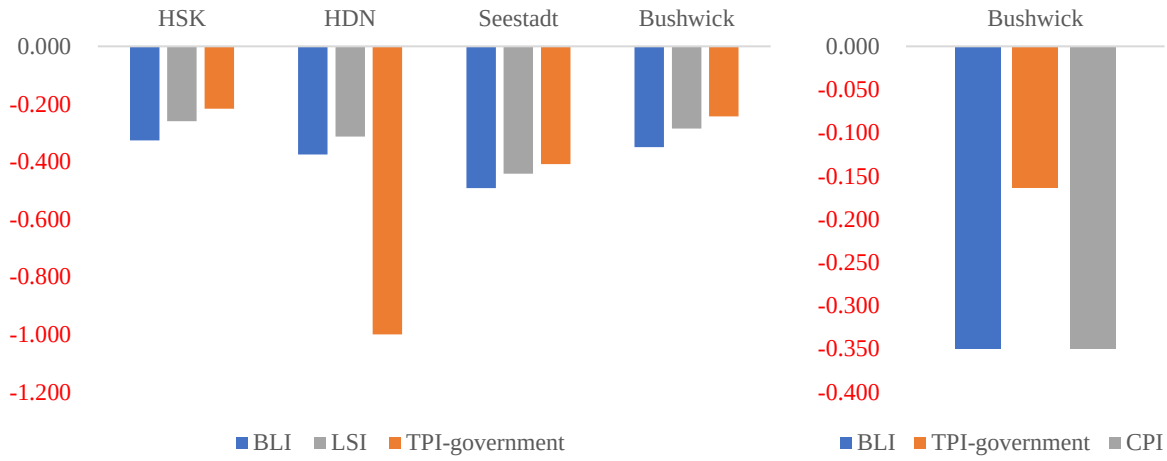
Index	BLI	LPI	HPI	CSI	ASI	LSI	TPI-indiv	TPI-gov	R_g
Initial value (Scenario A)	1	1	1	0	0	1	1	1	0
Final value in the four cases (Scenario C)									
HSK	0.673	1.100	1.147	1	1	0.740	1.147	0.772	32.7%
HDN	0.625	1.100	1.150	1	1	0.687	1.150	0.718	37.5%
Seestadt	0.507	1.099	1.143	1	1	0.557	1.143	0.579	49.3%
Bushwick	0.650	1.100	1.141	1	1	0.715	1.141	0.742	35.0%

As seen in the table, the values of BLI, LSI, and TPI-government are predicted to decrease in all cases. BLI equals to ($1-R_g$) and the final value of R_g is derived from the questionnaire survey of each case when CSI=1. For example, the largest R_g of 49.2% in Seestadt is combined with the smallest BLI of 0.51. As a result, BLI is different in the four cases, as are the relevant indexes of LSI, and TPI-government. The accessibility of UGS lead to the increase of LSI by 10% in all the cases, since the land plots are fully located within the catchment area of UGS. The value of HPI and TPI-individual are recorded around 1.16 due to the shortened distance to UGS and are almost the same in cases.

6.4.3 The utility of agents in optimized patterns

In the optimized layout, all the indexes related to Government utility show adverse changes, not only in the cases with public land ownership but also in Bushwick under private land

ownership (Fig. 6.12). From the perspective of a private land owner, Fig 6.12 suggests the index of LSI presents negative value, indicating the utility is likely to be reduced if the increase of CPI could not cover the economic loss in LSI. Although the positive/negative attributes of other indexes resemble those in planned pattern, the absolute values of these indexes are enlarged in the optimized pattern.



(a) Cases under public land ownership *(b) Case under private land ownership*

Figure 6.12 The changes of indexes related to the utility of government (C-A)

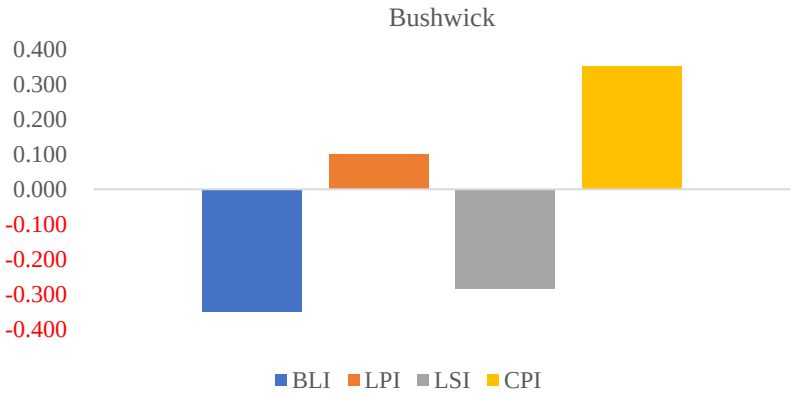
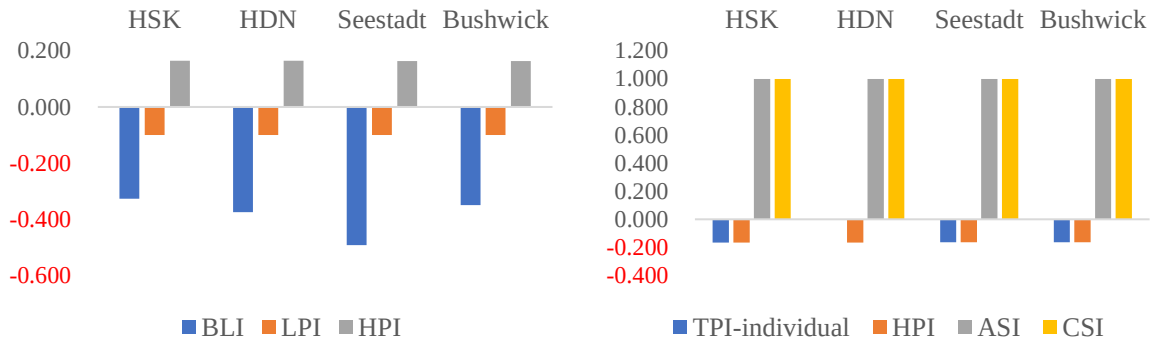


Figure 6.13 The changes of indexes related to the utility of private land owner (C-A)

In Fig 6.13, the condition of Developer is about the same as in Scenarios B. Both the increase of HPI and decrease of BLI and LPI coexist. As for the public, house buyers will bear more to afford the greener environment when the majority enjoying the improved availability of UGS. To achieve the goal of maximum public welfare, the values of ASI and CSI reach to 1 in all cases.



Developer *Public*

Figure 6.14 The changes of indexes related to the utility of developer and public (C-A)

Taking the all-developed pattern as the baseline, the utility changes in optimized scenario indicate the trade-off of interests in the designated pattern. Next, the utilities in planned UGS layout and optimized layout will be compared to understand the differences between the market condition and the target, as well as the barriers to maximizing public welfare.

6.4.4 The gap between market outcome and expected welfare

The final index value of optimized layout in Scenario C is compared with the planning layout in Scenario B. The potential changes in the value of index under different land use scenarios are demonstrated in Table 6.8.

Table 6.8 Change of the index value from the market condition to the optimized pattern (C–B)

Index	BLI	LPI	HPI	CSI	ASI	LSI	TPI-indiv	TPI-gov	R_g
HSK	-0.135	0.004	0.017	0.036	0.607	-0.146	0.017	-0.142	13.5%
HDN	-0.220	1.001	0.014	0.010	0.937	-0.242	0.014	-0.241	22.0%
Seestadt	-0.229	1.007	0.018	0.037	0.812	-0.246	0.018	-0.248	22.9%
Bushwick	-0.327	1.005	0.033	0.051	1.000	-0.355	0.033	-0.341	32.7%

As UGS is expanding, BLI, LPI and LSI are predicted to continuously reduce under Scenario C than under Scenario B, while other indexes show increasing trends.

It is interesting to note that regarding the relationship of "LSI = BLI * LIP", BLI is predicted to change in a much larger percentage than LPI, and LSI is predicted to decrease by 1.5%~3.5% in four cases. Similar results were obtained in the similar relationship of BLI, HPI and TPI-government where "TPI-government = BLI * LIP". This may be in part due to the model characteristic, such as the set of parameters and the formula for the indexes. However, the results provide a possibility of utility changes from the market condition to the welfare-oriented

land use. Based on the analysis, indexes which may lead to the loss of agent utility are identified. See the following table.

Table 6.9 The indexes associated with the loss of utility in the optimization of UGS provision

Agent	Indexes related to the loss of utility
Government (in c*ases under public land ownership*)	BLI, LSI, TPI
Government (in c*ases under private land ownership*)	BLI, TPI, CPI
Private land owner	BLI, LSI
Developer	BLI, LPI
Public	TPI, HPI

Table 6.9 summarises the obstacle indexes associated with utility loss when optimizing the UGS layout. BLI is an indicator of extremely high influence on the utility of agents, since how much land could be developed is directly conflicted with the UGS supply. Associated with the amenity value of UGS, the changes in HPI, LSI, TPI, are likely to lead to loss of utility of all the agents. Conservation payment is a conditional event in UGS provision and CPI poses a barrier for government in cities of private land ownership. Overall, governments seem to be more sensitive than other agents in this system, even though the utilities of all the agents will be affected.

6.5 Comparison of Market Mechanisms and Barriers to Optimization

6.5.1 The characteristics of market mechanisms

Under different market mechanisms, governments play varied roles in urban planning and development. In case of HSK, HSN and Seestadt, government performs as land owner, land seller, and even buyer. Their interests are more closely connected to the provision of UGS, which means the reduction of saleable land for development. However, in case of Bushwick, the utility of private land owner is more easily affected by UGS provision, either in positive or negative way. Since private owners are sensitive to economic benefits, it is difficult for them to support UGS provision unless enough incentives are given by government. Referring to the utilities of developer and public, similar trends are observed in the four cases. Under different market mechanisms, barriers to improving UGS provision in terms of different agents are

identified by comparing the changes in utilities between the current market-oriented and the expected outcomes.

6.5.2 Economic barriers in the four cases

The efficiency of land resource allocation is important for economic development of a city, since economic activities could not be conducted without sufficient and appropriated land supply. Among the indexes applied in the mode, BLI which represents the supply of built-up land is most influential one impacting the interests of almost all the agents. The provision of UGS results in the reduction of land for built-up uses, and one possible approach to mitigate the impact is to increase the density of development. However, if a city is limited in buildable land resources, such as HK, the high density may lead to other externalities. The increase of price indexes (LPI and HPI) associated with amenity value of UGS, is beneficial for the property sellers but shows adverse effect for buyers; e.g. some of the residents could not afford the houses close to UGS. Strategies of affordable housing in NYC, public housing in HK, price subsidy in Vienna, etc. are effective ways to overcome the barrier.

Local governments in cities under public, semi-public and private land ownerships confront different barriers regarding UGS provision. A government who publicly owns the land, means it is more feasible to provide public UGS, while expenses for land resumption under semi-public system and payment for purchasing development right for UGS under private land system are the main constraints government have to concern. In case of Bushwick, it is difficult for government to purchase private land for UGS due to financial constraints and land availability. The new UGS was obtained by negotiating with private land owners who want to change the density of their land, and for which specified conditions of providing UGS for public use was written into the rezoning document. The variations in land systems and the barriers also lead to differentiated UGS supply approaches. For example, a great contribution of the easements on conserving kinds of natural resources has been achieved by land trust organizations and conservation-oriented private landowners in America, but conservation easement is not popular in public and semi-public markets.

6.5.3 Non-economic barriers in the four cases

Superficially, the barriers for maximizing public welfare in terms of UGS provision are economic concerns related to the competing land resources and property market. However, the fundamental determinant is how the society values UGS, which is an ideological issue related to public awareness of the importance of their living environment. Multiple strategies in both

economic and non-economic perspectives are required to optimize UGS provision. Regarding the barriers of regulations, economic issues, public awareness and other uncertainties in conservation development, governments need to make more efforts to alleviate concerns of landowners and other agents. Alleviations of these concerns can be achieved in several ways: by refining and clarifying regulations, providing incentives of density bonuses, tax deductions and expedited approval processes, educating and soliciting residents input to conservation, delivering information about resident demand to developers, educating planning staff, etc.

6.5.4 Approaches for improving UGS provision in market perspective

Confronting the conflict in land resource allocation between UGS and other built-up uses, the primary approach to promote UGS supply is to increase land for built-up uses to meet the development requirement. The increase of density or density bonus is an encouraging incentive to overcome the barrier of BLI. High-rise apartment in Seestadt, high density development in HK, building a new park by landowner as an exchange for increased density in Bushwick have been used to achieve urban land supply. In conservation development of US, density bonus was the most common incentive to increase in development yield (Reed et al., 2014). For government, the reduction in total TPI may be compensated by increasing the types of taxation or the rate of property tax. However, the balance of wealth distribution among different kinds of taxpayers and housing affordability should be paid attention, since the rising tax and housing price will negatively impact on the utility of public house buyers. Developer and landowner need incentives to make up the loss of more expenses related to LPI over LSI. Monterey subsidies, allowance and bounds would possibly be the direct approaches. Further considerations of applying these approaches are discussed and recommended in Chapter 7.

CHAPTER 7 SUMMARY OF RESULTS AND DISCUSSION

This Chapter first summarises the findings and results of analysis presented in the former chapters, based on which issues in MD of UGS provision are discussed. The two most common issues arising in MD are those of adverse selection and moral hazard. Regarding these two aspects, Section 7.2 and Section 7.3 point out the problems in the four studied cases as well as the strategies applied to address these two issues, supplemented by worldwide experiences of other UGS provision cases. Section 7.4 discusses the matters associated with MD that both scholars and practitioners need to be aware of. In view of the above-mentioned perspectives, recommendations for UGS provision are suggested in the last section of this chapter.

7.1 Summary of Results

7.1.1 Summary of literature review

In the study area of land use planning policy, growth management and ecological conservation are two hotspots. Policies aiming to contain urban expansion, protect environment and promote urban landscape have been raised, while Urban Green Space (UGS) as one of the most important components in landscape, has attracted greater attention in recent studies. The environmental and social benefits of UGS as well as its amenity values are perceived in worldwide scopes, and the public show interests in UGS availability. However, failures in UGS provision and barriers to optimizing landscape have been observed in many cities, together with the external issues such as gentrification and displacement.

The outcome of the landscape highly depends on what kinds of roles are played by agents in the land-use decision-making process. Due to the public goods attribute of studied UGS, local government is the principal-agent as the supplier while the public are the demander and user of UGS. In addition to these two Key Agents, agents with special-interest in real estate development and agents with special-interest of environmental conservation can also exert an effect in urban planning and the property development market.

To explore the rules/approaches to achieve an expected outcome based on the preference of agents, the theory of Mechanism Design (MD) is a good point of entry. In MD of UGS provision, the understanding of agents' interests and utilities in a given landscape, as well as the expected outcome are essential to design the rules of gaming. Governments' interests in land development and UGS provision are varied among cities/countries regarding different contexts of land ownership, development mechanism, taxation system, etc. Members of the

public attach different importance to natural and openness features. In the condition of competitive land markets, there are risks of utility loss and the possible mis-carry of an excellent plan. Therefore, incentives are important to encourage the rational agents to follow the rules and achieve the expected outcome.

Previous studies have explored agents' interests in UGS and approaches to improve UGS provision. However, little study has been conducted to understanding the ***overall*** interest equilibrium under a system-wide context, or to linking empirical differences with any theoretical basis. Accordingly, the framework of mechanism design for agent-based land resource allocation is hereby proposed in this study, providing an insight into system-wide mechanism design of land resource allocation, which could be applied to explain the principle-agent problem and interest divergence in UGS supply.

7.1.2 Summary results of comparative case study

In political, social and economic perspectives, analyses are conducted in Chapter 4-6 to understand and compare the roles and interests of agents under different mechanisms corresponding to the four cases.

Chapter 4 explores the roles and interests of local government in land development and UGS provision through revenue-based attitude analysis. Governments' barrier or motivation to allocate green spaces could be affected by a land development mechanism, since revenues from land sale and property tax would directly reduce if a percentage of land was preserved and unavailable for developing, and the change in revenue varied among mechanisms. Three aspects of earning capacity in land development, profitability in providing UGS, and stability of revenue income in land use change are assessed to compare the attitudes of local governments in UGS provision of the four cases.

In the four cases presented here, the development mechanism of Seestadt performed best in terms of both earning capacity and profitability, followed by HSK and HDN, with Bushwick the worst. However, reversed ranks were observed regarding the attribute of stability. Such reversal indicates that land ownership is the most complex influential factor in land development mechanisms. Governments under public land ownership, such as the case the Seestadt, tend to be more supportive to UGS provision due to low risk in revenue loss. Private land ownership is disadvantaged in land availability and governments' affordability on land conservation. The semi-public land markets (HSK and HDN), existed in the 'crack' of public and private systems, resulting in local governments' contradicted attributes to environmental

planning. The reliance on property tax will benefit the stability of revenue and be positive to UGS provision. By comparing how the UGS planning standards are regulated and powered, Seestadt and HSK perform superior than HDN and Bushwick, indicating the importance of planning standards on shaping the landscape.

Responding to Proposition 1, the results in Chapter 4 suggest institutional mechanism is influential to the planning outcome. However, the assumption that institutional mechanism with less sacrifice of governments' self-interests in UGS provision are more beneficial to the outcome is doubted. According to the Section 4.5, the performance of institutional mechanism not only depends on government self-interests, but is also influenced by city-based factors, such as land development process, governments' role in land market, land ownership, taxation system, the power of the planning standards, etc.

Chapter 5 focuses on public utility, in which public interests in land use and their roles in planning participation are examined by investigating public desire through a questionnaire and evaluating the effectiveness of planning participation. Multiple approaches are applied in the cases of Seestadt, Bushwick and HSK, while in HDN public participation is limited to only publicity. The analysis of the questionnaire survey shows public from the four cities attach divergent importance to each item as well as to different land uses. UGS is valued much higher by respondents in Seestadt than in the three other cases. The utility functions of the public are differentiated in demographic groups and between cases. Populations of senior citizens and less educated people generally do not request for more UGS, while those with high income or dissatisfied with current greenery landscape request for more than other groups. Referring to willingness to payment (WTP), the extremely high income is estimated as the most significantly positive attributes. It seems that UGS is like a luxury, the majority desire for it but only people with extremely high income are willing to pay for it. However, analysis of Seestadt shows that people there perceive in an inherently probabilistic manner, whatever the demographic features are. Such perception may be caused by the social consensus of environmental importance and the mitigation of negative externalities associated with UGS provision. Through comparing the participation process and subjective assessment of outcome, it is concluded that a relatively good planning process will not definitely lead to a good outcome, such as a greener layout with more UGS. The worst participation process of HDN did not produce the worst outcome, since government with powerful decision authority could be trusted under certain conditions. Even though participation in Bushwick is diversified, the public are empowered in a relatively narrow scope, and the outcome further illustrates that the

decision-making power may not be authorized to governmental departments but to where the money comes from. In terms of public utility, a greener landscape is not related to high public satisfaction/ utility, since the satisfaction conditions set by the public are different among the cases.

Proposition 2 assumes the more public participation there is, the more effects will be imposed by public or environmental groups on UGS planning. Results in Chapter 5 indicate it is not always a truth. The effectiveness of the planning participation mechanism is also determined by case-by-case factors such as social awareness of environment, social consensus, the scope of planning, the power of government authorization, etc., making the mechanism difficult to be quantitatively evaluated.

Chapter 6 measures the utilities of agents in UGS provision under the four market mechanisms using agent-based CA model and identifies the barriers to maximizing public welfare confronted by different agents. It is concluded that the optimization of UGS provision is a process of balancing divergent interests of Key Agents. These interests are related to the context of the city, not only to the status of economic development, income and ownership, but also to social conditions such as environmental consciousness as well as political factors such as the goal of government, participation effectiveness, etc. The increase of UGS will reduce the supply of buildable land. In addition, this research revealed that when optimizing UGS provision, the reduction of land sale income and tax collection, and the increase of conservation payment may advisedly impact on government utility, while house buyers may bear higher house price and taxation payment. Corresponding incentives are needed to achieve agents' compatibility and make the optimized plan implementable.

It is assumed in Proposition 3 that the marketization of public goods such as UGS, will facilitate the effective supply of UGS and mitigate the problem of market failure. The Proposition is founded well when providing a relatively small quantity of UGS; however, if targeting at maximizing public welfare, marketization of UGS will not work and extra incentives are needed to achieve compatible and rational behaviours.

In summary, the study indicates that each mechanism contains its own strengths and weaknesses. The allocation of UGS in case of Seestadt performs best regarding revenue and social utility, and the success of which is attributed to many factors, including the public ownership of the state-owned land, high environmental awareness of public and effective participation, modest housing demand in market, capable government, etc. However, this case

is too ideal to be implemented and spread in other parts of the world. Taking the economic benefit of development into consideration, HSK is a sustainable project to achieve integrated economic, environmental and social effects. The issue of land availability and lack of public participation are the main constraints to the UGS provision of Bushwick in USA and HDN in mainland China, respectively.

Overall, the mechanisms of public UGS provision are demonstrated in three chapters, in accordance with three levels identified, and the influential factors at each level of the mechanism are derived from the comparative case study. See Figure 7.1

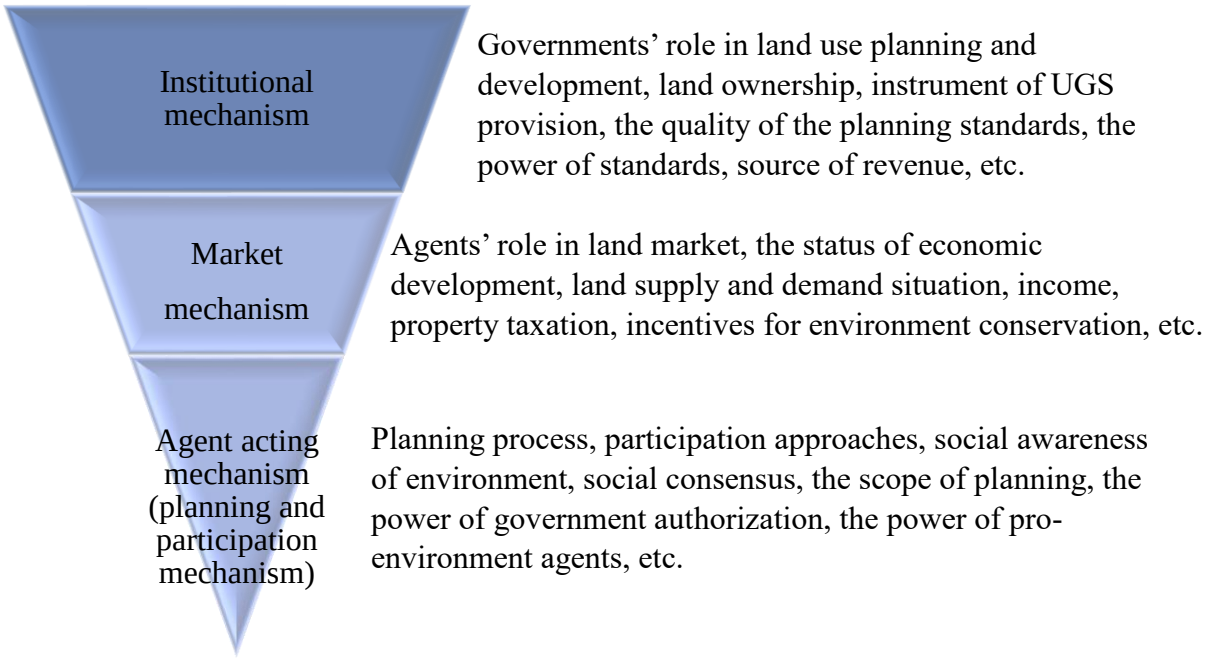


Figure 7.1 Hierarchical mechanisms of UGS provision and systemic factors

The basic hypothesis of this thesis is stated as the mechanism that better meets public needs at less sacrifice of utilities of other agents facilitates better UGS layout, following which three propositions are proposed in the condition of rational individuals/agents. According to the results, all the three propositions are not supported, implying the complex and interacted relationships among all the agents under the hierarchy of the mechanisms. The performance of UGS provision outcome (Y) is dependent on synthetic effects caused by a set of variables (X) rather than one influential factor and formed in the hierarchy of the mechanisms rather than in one aspect of the mechanism. Even though the propositions are modified by taken more variables into account, the hypothesis itself may still be tenable. In case all variables being considered, the relation of X/Y could be theoretically concluded that the mechanism that better meets public needs, at less sacrifice of utilities of other agents, facilitates better UGS layout.

However, the better mechanism together with better outcome is constrained by many factors in the real world. Seen in another way, the provision of UGS is not determined by one key agent or one influential factor, but is a common mission related with every individual under a particular city context.

To generalize the results in understanding the mechanism of UGS provision beyond the studied four cases, further discussion will be conducted. Theoretical issues of adverse selection and moral hazard in MD and the design of the gaming rules are elaborated. Additionally, worldwide experiences of other UGS provision cases are included as supplementary references, to show more possibilities of overcoming the barriers for optimization.

7.2 Adverse Selection in UGS Provision

7.2.1 Selection of the planning guidance

The urban planning standards or principles are the important guidance for government to provide UGS (Section 3.2.2 and Section 4.5.2). In the cases of HSK, HDN, and Seestadt, the planned UGSs have met the criteria. However, in Bushwick there is no such kind of guidance to regulate how much UGS should be provided and how to distribute them. Correspondingly, the performance of UGS pattern of Bushwick is inferior to other cases. Differences in standards are obvious among cities. Regarding proportion of UGS per capita, Vienna (16.5 m^2/person in standard) performed in a relatively low level compared with most European cities with 25~125 m^2/person UGS (Baycan-Levent & Nijkamp, 2009). What is worse, the local UGS supply in HK is at merely 2.84 m^2/person in 2014, while the standard of 2 m^2/person is outdated which have remained unchanged for eight decades (Jim & Chan, 2016). The setting of planning guidance is the baseline of UGS provision, while the outcome of urban planning could hardly perform well without appropriate standards.

7.2.2 Selection of public desires and the externality

As indicated by the questionnaire survey in the four cases, public desires for UGS are complex and diversified (Section 5.4.3). Some variations in their preferences are related to demographical features of gender, age, income, and education, while some others are not. The lack of information of public preference will lead to inappropriate allocation of land resources, e.g. the insufficient UGS supply, unjust distribution, poor quality, etc. and urban people may be unsatisfied with the existing or planned UGS. Apart from questionnaire survey conducted in this study, more innovative approaches can be applied to explore public desires, e.g.

visioning of nature with different landscape features (Gobster, 2001) and action learning to obtain their experiences and expectations (Richardson & Grose, 2013). While learning and satisfying public desire of UGS, the externality of UGS should also be noted since it may adversely impact on public utility regarding their requirements in other aspects. The rising housing price and rent is one of the most important externalities. Gentrification and a displacement of the very residents are the issues following UGS strategies (Wolch et al., 2014). The population who want to live closer to UGS may be forced to move far away from the UGS since they could not afford the house there. To enhance the affordability of properties around UGS, in Seestadt planning, government-subsidized housing is mixed with private housing to avoid the impact of increasing house costs and ensure the accessibility of UGS to the overall public. Research studies also pointed out approaches to deal with the mismatch of UGS and user preferences, such as evaluating UGS distribution, matching between quality of a park and specific cultural and age-dependent user-needs, protecting social sustainability, etc. (Kabisch & Haase, 2014; Wolch et al., 2014).

7.2.3 Selection of interests among multiple agents

With growing GDP and population, building demands would continue to increase worldwide (He et al., 2015; Reginster & Rounsevell, 2006). As demonstrated in the agent model (Chapter 6), the increase of UGS is always combined with the decrease of built-up land supply, together with the changes of other indexes which represent the interests of different agents. As highlighted in urban growth theory, the local landed elite leverages both political and economic advantages to maintain power and control over urban growth and development (Logan & Molotch, 1987). The lack of information about public desire of UGS as well as the free-rider problem may lead to the neglect of their interests. The interests can be monetary or ecological, short-term or long-term, with flexible effect or irreversible consequence, etc. To prioritise environmental considerations as well as to involve public in early stage of decision-making are important to UGS planning among multiple interests. Government, as the mechanism designer, will set the target and to some extent determine what interests are to be considered and what to be neglected. Either maximizing profit or maximizing social or public welfare, the objective will affect the outcome of UGS provision.

7.2.4 Selection of heterogeneous land resource and ecosystem service

Although in the case study, the lands for development were regarded as homogeneous resources due to data availability, in broader scales of cities or regions, the spatial heterogeneity

of land is obvious. The ignorance of the value of ecosystem services is one of the reasons of spatial inequality (Cilliers et al., 2014). When selecting land for UGS, the lack of information about the characteristics of land resources will impact the ecologic functions of the UGS as well as the region. Research studies have suggested to integrate natural enclaves and ecosystem services such as plant biodiversity, food production, microclimate control, soil infiltration, carbon sequestration, visual quality, recreation, and social capital, into both small-scale greening projects and the built environment of packed neighbourhoods (Jim, 2004; Lovell & Taylor, 2013). In the case of HSK, multiple reports focused on "Air Ventilation", "Cultural Heritage and Ecological Baseline", "Sustainability Assessment", "Geotechnical Assessment" and other related technical issues were published to better understand the characteristics of the land resource in this region. They provided useful knowledge to select the locations of UGS as well as of built-up land and improve the ecosystem service of the area. In addition to technical reports, public perception of UGS could also be helpful. Previous studies of participating planning in Netherlands invites people to identify the quality of land by thinking about the use and experience values of spatial aspects and rate them according to importance and vulnerability (Cilliers et al., 2011).

7.3 Moral Hazard in UGS Provision

7.3.1 Self-interests of government and indifference to UGS

Supported by the result of modelling (Section 4.5, 5.5 and 6.5), it is found that government is the agent contributing most in the provision of public UGS, in terms of policy making, financial loss, efforts in planning process, etc. On one hand, local government is responsible for UGS provision; on the other hand, they will concern personal benefits as well as other interests of the city, some of which may conflict with the supply of UGS. Income associated with land sales and real estate transactions and taxation is an important source of revenue for local governments. They are likely to focus on land and real estate development rather than concentrating on the externalities of markets. It is found that some local government fail to adopt the standards due to the pressure of urbanization (Haaland & Van Den Bosch, 2015), while some municipal authorities do not have any specific plan, programmes and activities, nor is there any public involvement to promote urban greening (Lamichhane & Thapa, 2012). Even though the state government emphasized the importance of land preservation, local governments resisted state intervention and were guided mainly by self-interest and peers' actions when deciding whether or not to change their ordinances for encouraging preservation

(Loh, 2015). Governments perform as rational agents, whatever the management system is. If the provision of UGS could not enhance their utility, such as personal income, recognized achievement, vote, reputation, etc., it is difficult for local government, as a rational agent, to support environmental planning.

7.3.2 Self-interests of public and the lack of participation

The free-riding problem was discovered in UGS provision. As suggested by the questionnaire survey, most of the public in HSK and HDN do not care much about the UGS, while in Bushwick not many people who attach high importance to UGS have participated in the planning process. In Seestadt, the use of a questionnaire survey by mail before the formulation of the plan facilitates individual free riders to participate, and additionally, to empower the citizens in decision-making, individuals are nominated as "Experts on the ground" who are given seats to vote in the planning commission. Those approaches have increased the utility of free riders. What is more, efforts made to deal with the free-riding issue are not limited to that. Incubators could be offered to catalyze citizens' willingness to 'do their bit' for improving spaces and such measures foresees a set of interventions (Caneparo & Bonavero, 2016). The role of public in planning could be strengthened, e.g. through reading scenarios of land use change, increasing participation willingness and perceived self-efficacy (Johnson et al., 2016). Planners together with professional associations, are encouraged to translate scientific ecosystem approach into practical planning and management tools for people to understand (Everard, 2013).

7.3.3 Self-interests for development and profit

The target of urban planning development to deal with population growth by setting accommodations, while the local citizens were generally opposed to growth (Brown & Chin, 2013). Apart from the objection of affected local residents, developers are motivated mainly by profit maximization in development and may neglect the importance of UGS. Developers are expected to be especially responsive to economic measures such as taxation or subsidies or be sensitive to development factors and regulative constraints that may affect their profits (Maruani & Amit-Cohen, 2011). As indicated by the results shown in Section 6.3.3 and Section 6.3.5, the provision of UGS will influence on developers' profit, through its positive effect on HPI and negative effects of decreasing BLI and LPI. Since only public UGS is concerned in this study, the role of private developers is to participate in decision-making and with a tendency to support more development (high BLI). Incentives to improve the utility of

developers are advised to be market-oriented, such as density bonuses, tax deductions, conservation subsidies, expedited development processes, providing information about resident demand, etc. (Allen et al., 2012; Bowman & Thompson, 2009; Göçmen, 2014; Reed et al., 2014). It is worth noting that the interests of developers differ according to their characteristics. For example, the private entrepreneur is focused more on maximizing profit, while the public organization is supposed to pursue public interests aside from profit chasing; furthermore, compared with public State developers, municipal developer/local officials resemble the private developer in the aspiration for maximum financial revenues (Lichtenberg & Ding, 2009; Maruani & Amit-Cohen, 2011). In case of Seestadt, the development company is a public organization concerning societal values, a factor which may be one reason for the greener landscape.

7.3.4 Roles of environmentalists and their self-interests

An organized group of people is more likely to be empowered in decision-making than individuals, which is also an effective way to avoid the free-riding problem. In case of HSK, voices from green groups and a governmental environment institute were considered in the plan and some ecologically sensitive area was protected. Environmental Non-Governmental Organization (ENGO) played significant roles in Bushwick, through participating in the activities such as Open Space Summit and giving advices to UGS improvement in the community. Nevertheless, ENGO also has its limitations. According to the interview with HK district councillor, ENGO may be beholden particularly to a political party, making things more complex with little effective outcomes, which should be paid attention when taking advantage of their support.

7.4 Mechanism Design and Rules of Gaming

7.4.1 Interests trade-off under different mechanisms

Diversified and conflicted interests were found in the perspective of different agents. Because of asymmetries in economic and political strengths between interest groups, it is challenging for planners to mediate the divergence between competing interest groups and negotiate with parties to divide their mutually beneficial gains (Hawkins, 2014). Whatever the development/planning mechanism is, interests could be traded in various approaches. For example, market feedback of the amenity premium and price increase has been considered in the proposed agent-based model. As supported in a previous study, integrating planning via

adaptive cost coefficients will reduce the losses in biological conservation (Toth et al., 2011). Regarding the analysis methods, gaming theory is used to analyse the output of a designated mechanism (Vohra, 2011), such as the effect of ecological compensation on UGS supply (Lin & Li, 2016). The tool of cost-benefit analysis is applicable in analysing incentives and disincentives facing principals and agents in the context of UGS provision (Hotte et al., 2016). Based on the learnt utility function of actors, the "Multi Agent based Land Use Planning Support System" enables agents to negotiate with each other about the spatial land use configuration on behalf of their associated actors to improve their satisfaction levels (Ghavami et al., 2017).

7.4.2 Information transfer and interaction

According to MD theory, adverse selection and moral hazard occur due to asymmetric information. The provision of UGS requires both agent-based and human-environment information. Previous study of urban green infrastructure in Italy and other European stakeholders suggested there is a need to better understand the importance of forming cohesive teams, of optimizing financial resources, and of finding a common language to bridge their diverse disciplinary backgrounds (Ugolini et al., 2015). To integrate the components of ecological and social systems, ecology-oriented questions of quantity, quality and needs of urban nature, and human-oriented drivers, such as flow and incorporation of information, knowledge, values and institutions should be considered for creating a common conceptual ground (Yli-Pelkonen & Niemela, 2005). Regular coordination, cooperation and monitoring are required for the involvement of various stakeholders such as municipality, government office, community organizations, associations and academia representatives and urban people, in various formats (Seminar, Participatory Day, Workshop), and coupled with adequate institutions and financial resources (Lamichhane & Thapa, 2012; Magrinyà et al., 2014).

7.4.3 The context of institutional arrangements

The design of the mechanism should concern both individual and institutional perspectives, while the latter is important in comparative study since the variation of agents' interests is the outcome of different conditions. In addition to the institutional factors studied in Chapter 4 regarding urban development mechanism, on a broader scale, institutional arrangements such as political environment, institutional structure, etc. may also be important. As for the principal of UGS provision, the preference of decision-makers in multi-party countries on the basis of median voter theorem is to satisfy the wishes of the voter who guarantees a majority, in order

to be re-elected (Choumert & Salanie, 2008). However, in one-party countries, the behaviour of local government is motivated by the up-down official promoting system. Local government in China has been actively pursuing land development as a means of revenue generation to finance local economic growth, and consequently the pursuit of maximizing land lease revenue may even cause the loss of public green spaces under increasing urbanization (Chen & Hu, 2015; Lin & Yi, 2011).

7.4.4 The context of economic environment

The mechanism of UGS provision is connected to the overall environment of the city/country, economic status and land resource condition as two important parameters. Among the regions/counties of the studies cases, Hong Kong, Austria and US are taken as high-income economies, while mainland China is a lower-middle-income economy[31]. Narrowing down to city-level comparison of generalized living standards represented by GDP per capita (PPP)[32], it New York (US$ 63372[33]) > Hong Kong (US$ 40247[34]) > Vienna (US$ 39259[35]) > Beijing (US$ 28168[36]). Economic conditions will affect economic decisions of resources allocation and apportioning of goods and services, which may produce different valuations to economic development and living environment. As indicated from the questionnaire survey of HDN, Beijing, people value land uses of Transportation, Housing, and Commerce more important than UGS. The shortage of land supply in HK has led to high-density city development, which is one of the reasons to low standard of UGS provision as well as the scarcity of public UGS (Jim & Chan, 2016; Yung et al., 2016). Accordingly, people around HSK underline built-up land and think little of UGS.

7.4.5 The context of ideological environment

How will cities treasure environment and UGS? The answer to this question would be complex but is likely to be related to their ideologies and values. Governments, the principal of UGS provision, show different characteristics. E.g. government's structure is determined by instrumental considerations, historical development as well as by ideological views with respect to the desired regimes and the distribution of social power (Rausser et al., 2011). Even

[31] The World Bank Group. http://go.worldbank.org/47F97HK2P0
[32] The data at Purchasing Power Parity (PPP) in year 2014 is used for comparison. PPP conversion rates refer to www.imf.org/external/datamapper/PPPEX@WEO/OEMDC/ADVEC/WEOWORLD/AUT
[33] https://www.opendatanetwork.com/entity/0400000US36/New_York/economy.gdp.per_capita_gdp?year=2014
[34] https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=HK
[35] https://www.wien.gv.at/statistik/pdf/viennainfigures-2016.pdf
[36] http://www.bjstats.gov.cn/tjsj/tjgb/ndgb/201511/t20151124_327764.html (in Chinese)

within a city, people have various thoughts, which has been present in their answers of every questionnaire. There are many possibilities behind the differences. For example, the zoning preferences are influenced by the actor's socio-economic status, objectives, the nature of 'market failure' it experiences, and the benefits and costs from political debates and outcomes (Qian, 2010). Whatever the values, planning outcome depends on interaction among different stakeholders, based on communication of their values and coordination of their interests.

7.4.6 Discussion of incentive compatibility

From the results of the MD models, every agent may have the possibility to bear utility loss due to urban development and UGS provision. Under market conditions, the quantity and accessibility of UGS could hardly reach the level that the public are satisfied with. On the contrary, when chasing maximum public welfare, government, private land-owners and developers are likely to confront financial loss and less buildable land resources. In order to improve public welfare without compromising the utility of other agents, therefore, incentives are needed. One of the most common approaches is intensive and mixed land use, since the increase in the percentage of green space in urban development is to be performed in combination with densification activities (Lehmann, 2010). Other potential tips which have been proved feasible in plural cases worldwide, such as to integrate land acquisition strategies (Gerber & Rissman, 2012), to transfer development right (TDR) for UGS supply (Linkous & Chapin, 2014), to innovate public policies and greening technologies (Jim, 2013), and to take advantage of civil power (Guyot, 2011) are worth for further exploration. Taking compatibility as the target, where all the agents involved are willing to act as the mechanism wants, measures/strategies should be designed to avoid the reduction of their utilities, detailed approaches of incentives for optimize UGS provision should be bound up with localized city context.

7.5 Recommendations for optimizing UGS provision

The study has demonstrated and discussed the influential factors to the performance of UGS provision in urban planning development process as well as the potential possibilities to deal with related issues, based on which the approaches to improve the provision of UGS are suggested. Each item recommended below are referred to the analysis, findings, and discussions in the corresponding sections. Since a comparative study of four cases in different cities is conducted, the recommendations could be regarded as a pool of general principles or guidelines for optimizing UGS provision in broader international view.

7.5.1 Sustainable planning strategies

The principles, standards, and techniques of planning are important to optimize UGS provision and recommendations regarding sustainable planning strategies are:

- *To improve planning standards for the quantity, quality and distribution of UGS (ref. Section 4.5.2).*

  A hierarchy of UGS provision criteria, regarding accessible distance, population density, demographic characteristic, the scale, type and catchment area of UGS, etc., should be regulated in planning standards.

- *To upgrade the regulated planning standards according to peoples' changing needs (ref. Section 7.2.1).* The standards are suggested to be updated in a timely manner, rather than remain constant for long term. E.g. to enhance the average UGS area per capita, the accessibility, or the functions.
- *To prioritize UGS design in land use planning for sustainable planning and distribution justice (ref. Section 7.2.2 & 7.2.3).* Shaping UGS before the planning of built-up land uses, not only by conventional urban design and ecological value, but also by community concerns, needs, and desires for living environment. To conserve at first, and afterwards, to develop.
- *To integrate an ecosystem service into UGS planning principles (ref. Section 7.2.4).* UGS is a part of an urban ecological network or system, while lands with higher ecological values should be given prioritization to preservation.

7.5.2 Improving public awareness of the living environment

Peoples' concern is an important driving force to UGS optimization as well as urban sustainability. To improve public awareness of the importance of UGS, the following points are suggested.

- *To promote the importance of environment through life-long education (ref. Section 5.5.4&7.2.2).* Government should take various measures to spread widely the knowledge of environment and UGS in both the school education as well as re-education in society.
- *To raise public awareness through behaviour guidance (ref. Section 5.4.4 & 7.2.2).* Since public perception to UGS is related to their experience in using UGS, the more people use UGS, the better the experience is, the more they would like UGS. To guide

and encourage the use of UGS is helpful to improve public awareness in the urban environment.

- *To support and encourage the development of NGOs, especially ENGOs (ref. Section 7.3.4).* Well-organized groups of public bodies are more powerful in intervening in policy-making, and ENOG is an approach to convert free-riders to participants in the planning process and tell their requirements for UGS.

7.5.3 Improving the effectiveness of planning participation

To improve the effectiveness of public participation, recommendations are:

- *To provide different approaches for different agents to participate (ref. Section 5.5.4).* Various methods targeting at different kinds of people should be considered to enhance public engagement and encourage the public to contribute.
- *To involve the public at the early stage of planning (ref. Section 7.2.3).* Public opinions should be collected before putting forward the planning proposal rather than after drafting the plan.
- *To empower the public in decision-making (ref. Section 7.2.3).* Government should take the public opinions into account rather than completely dominate in decision-making with fake participation.
- *To instruct the public and improve their participation ability (ref. Section 7.3.2).* People are not born to be able to participate in urban planning. Instruction and education are essential for public to know the plan, express reasonable opinions and make grounded suggestions.

7.5.4 Collaboration for implementation and incentive compatibility

The outcome of urban land use is a collective work shaped by all the involved agents after interest trade-offs. To ensure the implementation of optimized land use plan, agents should communicate to know each other's interests and collaborate to make decisions. Potential strategies are as follows.

- *To properly adjust institutional arrangements, encouraging rational government to support the provision of UGS (ref. Section 4.5.3).* It is recommended to establish a positive relationship between government interests and UGS supply through institutional reform, providing incentives for government to support UGS provision. E.g. connecting the performance of UGS with the assessment of government

achievements.

- *To provide spaces for negotiation and interest trade-off, coordinating divergent interests in terms of public welfare (ref. Section 7.4.1).* Collaborations between local government, community groups, local stakeholders, and the urban planners, designers, and ecologists are essential. Confronting divergent interests in urban development, the planning of UGS should be regarded as a strategy aiming at public welfare and urban sustainability rather than emphasising on short-sighted benefits of privileged groups.
- *To transfer knowledge among agents (ref. Section 7.4.2).* To deal with information asymmetry, it is important to bridge multiple agents, transferring relevant knowledge and emerging efficient communication.
- *To design incentives for compatibility, based on agents' utilities (ref. Section 7.4.6).* The implementation of urban greening policies depends on incentive-compatible agents. Incentives in either economic or non-economic perspectives should be designed to improve the utilities affected agents.

7.5.5 Linking up the history and the future

The UGS provision could not be comprehensively improved without the understanding of city context, while measures should be adjusted in line with local conditions *(ref. Section 7.4.3 & 7.4.4 & 7.4.5).* Accordingly, a few principles should be highlighted.

- *To understand the context of current UGS provision mechanism.* The provision and optimization of UGS should be integrated with local conditions of economy, development history, institutional characteristics, public perceptions, ownership arrangement, society status, etc.
- *To objectively evaluate the performance of UGS, not only for present pattern but also for dynamic changes in future.* The improvement of UGS is based on the understanding of performance and features, which will be dynamically changed by time and with policies.
- *To set long-term goals for public welfare.* The designated goal provides the direction for mechanisms as well as the outcome. The optimized land use pattern with improved public welfares requires a good start with a long-term goal for urban sustainability.

Overall, 18 approaches were proposed in the above sections as recommendations for improving green space provision in urban development. To validate whether these recommendations are practical for acceptance by governments, a questionnaire was designed and sent out by email

to the planning departments of different cities. In the questionnaire, the approaches were listed after a few questions about the city, for example relating to name, land ownership, the importance of green space in urban development, etc. More than 50 emails were sent out worldwide to the planning departments of metropolitan areas in Africa, Asia, Europe, North America, South America and Australia. However, besides the four cities selected in this study that had already been contacted, only four cities returned the completed questionnaire. In total, therefore, eight cities have presented their views regarding the recommended approaches. They are Barcelona, Beijing, Hong Kong, London, Munich, New York, Singapore and Vienna.

Respondents were asked to rate their responses on a five-point scale ranging from strongly disagree to strongly agree, as follows: 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, and 5-strongly agree. All of the approaches scored an average of 4.0~4.8 with a standard deviation (STDEV.S) of 0.45~1.00; none of the approaches attracted the disagreement (scored 1 or 2) of any of the eight cites. Two approaches gained the highest score of 4.8, implying very strong agreement. One of these strategies is to establish a hierarchy of UGS provision criteria in the planning standard (e.g. accessible distance, population density, demographic characteristic, scale and type of UGS, catchment area, etc.), as mentioned in Section 7.5.1. The other is to set long-term goals for public welfare and sustainability in the city development plan, as mentioned in Section 7.5.5.

By contrast, six approaches gained the lowest score of 4.0. These can be divided into two groups. One of these groups gained the score with higher STDEV.S, which means most of the cities agreed while some advanced a neutral opinion. Such approaches include five approaches: promoting the importance of the environment, raising public environmental awareness, supporting environmental NGOs, transferring knowledge among agents and providing non-economic incentives. The comments from those cities presenting neutral opinions showed that they are not always responsible for activities in these areas. Therefore, the relatively low scores of these strategies are not necessarily linked to their effectiveness, but are more likely a result of their being beyond the scope of the planning department's duties. Only one item shows an average agreement that is not very high among all cities (with lower STDEV.S), namely the approach to empower the public in decision-making, suggesting the practicality of the public's playing a dominant role in planning decision-making may sometimes be questionable. In general, the recommendations derived from this study are deemed acceptable by the international city authorities.

CHAPTER 8 CONCLUSIONS AND FUTURE RESEARCH

This chapter highlights the most important points in findings, discussions and the contribution of this research to knowledge. This is followed by an evaluation of the limitations of this research and possible future directions for useful study.

8.1 Conclusions

The importance of UGS in urban development has been continuously emphasized due to its widely perceived environmental, social and even economic benefits. However, cities have witnessed the failure of UGS provision, not only in traditional land use planning but also in other urban landscaping approaches. To identify the barriers for optimizing UGS provision in land use planning and development process and figure out the characteristic of the mechanisms behind UGS provision, this research is conducted to address the key question of "why the outcome of UGS planning are different among cities?". It aims to understand the reasons behind the differences of UGS provision in the urban-fringe development of different cities. Based on the theory of Mechanism Design, three aspects of institutional mechanism, participatory mechanism and market mechanism are examined, respectively with the Key Agents of government, public and market actors at the core of analysis. Taken the four projects of urban fringe development as the studied cases (HSK in Hong Kong, HDN in Beijing, Seestadt in Vienna, and Bushwick in New York), the interests, preferences, as well as the utilities of agents are demonstrated, evaluated and compared.

In Section 1.3, four research objectives are raised which are to understand the current UGS provision mechanisms, to analyse the impact of the mechanism on agents' utilities and UGS layout, to optimise the UGS planning layout and appraise the hurdles/limitation in implementation, and to suggest the approaches for improving UGS provision. These objectives are achieved in later chapters of the thesis through multiple research methods.

To understand the current UGS provision mechanisms of the four cases, documentary analysis interview and field survey were conducted regarding each of the case. Section 4.3 illustrates the processes and mechanisms of land development under the current institutional arrangements case by case. Section 5.2 elaborates how the public participated in the planning and through what kinds of methods. Using the proposed agent-based CA, Section 6.3 demonstrate how UGS works in land market and effects on the utilities of agents.

The main parts of the analysis in this thesis is to address the second objective, which is to explore the impact of the mechanism on the performance of UGS provision and agents' utilities, or to show the relationship (X/Y) between mechanisms and the planning outcome. In Section 3.2.2, the performances of the planned UGS layouts were briefly assessed, with Seestadt rank the top, followed by HSK and HDN, and Bushwick the last. Analysis regarding the impact of institutional mechanism on government utility was demonstrated in Section 4.4 and Section 4.5. It indicates that the impact of institutional mechanism on UGS planning outcome not only depends on government self-interests, but also on city-based factors. Institutional arrangements with initial public land ownership, long-term property taxation, comprehensive planning standard, government capability to implement the standard, etc. are related to better outcome of UGS provision. Section 5.2-5.5 identifies the impact of participatory mechanism on public utility and UGS outcome. The results suggest the effectiveness of participatory mechanism is not only determined by the participation approaches adopted in planning processes, but by case-by-case factors such as social awareness of environment, social consensus, the scope of planning, the power of government authorization, etc. The impact of market mechanism is analysed in Section 6.3, where the utilities of different agents are linked to UGS layout and simulated. Different from only focusing on either the government in Chapter 4 or the public in Chapter 5, this part takes all market actors into account. It shows that the marketization of UGS will facilitate the effective supply of green space and mitigate the problem of market failure for situations that provide a relatively small quantity of UGS. However, for larger quantity of UGS extra incentives are needed to achieve compatible behaviours of the rational agents and maximize public welfare.

To optimise the UGS planning layout and appraise the hurdles/limitation in implementation, Section 6.3-6.4 simulates optimized UGS layouts and illustrated the changes in agents' utilities. and then applicable approaches are discussed and recommended in Section 7.2-7.4. When local governments allocate land resources for UGS, common issues of adverse selection and moral hazard are followed. The designing of an incentive-compatibility mechanism requires interest trade-off, information transfer, and interaction among agents, in the context of localized institutional arrangement, economic environment, as well as ideological environment of society. Any of the above items may become the hurdle of optimising UGS planning for a specific city or a development project.

To suggest the approaches for improving UGS provision, Section 4.5.3, Section 5.5.4, and Section 6.5.4 discuss the validity of influential factors identified in institutional, participatory

and market mechanisms, respectively, based on which recommendations are made. In addition, possible approaches which have already been successfully applied in other cities of the world are introduced in the discussion sections. Afterwards, recommendations for improving UGS provision in city development are summarised in Section 7.5. They include applying sustainable strategies of planning, enhancing public awareness of urban environment, promoting the effectiveness of public participation, facilitating communication and collaboration among multiple agents, and setting long-term goals for public welfare supported with dynamic and active management.

Although the provision of public goods is a central application of the theory of mechanism design, little has been done to apply this theory to UGS provision in the context of urban development. This study represents one of the first attempts to apply MD theory in understanding the overall interest equilibrium under a system-wide context, linking empirical UGS provision cases with theoretical basis. In contrast to focusing on a particular event, the mechanism is analysed with integrative framework of planning, development and marketization. In addition, to fill in the gap of comparative research in cross-city intercontinental scale, the study is conducted in an attempt to explore different roles and interests of agents involved in UGS provision of different cities. To achieve this target, agent-based CA model is established to quantitatively evaluate the utility of each agents under the context of each selected cities, contributing to better understanding of advantages and difficulties in UGS provision from a broader angle.

Moreover, challenges and strategies for UGS provision presented in the previous studies are mainly from a policy/governance perspective. This study further extends this topic in an economic and social perspective, based on MD theory and the principles of individual rationality and incentive compatibility. In this study, with the several indexes, the proposed agent-based model represents the performance of the UGS layout in terms of the utility of different agents involved, highlighting the confliction in different interests. Theoretical issues of adverse selection, moral hazard, and agent incompatibility were observed in empirical cases of public UGS provision. Strategies to deal with these problems have been explored and discussed. As a result, this study revealed important results that can be useful reference for policy makers, planners, and designers regarding how to improve the UGS provision and promote the public welfare of land use.

8.2 Limitations and areas for further study

The evaluation of UGS performance consists of quantity, quality and accessibility. This research only includes quantity and accessibility, since the aspect of quality involves another dimension of spatial analysis. The mechanism of how to improve the quality of UGS is worth further study. Due to the data availability, evaluations are conducted mainly based on relative values of indexes to illustrate the changes and differences. The work would be more useful for city development and planning if absolute values of the indexes and utilities could be calculated from more cases data.

The study focuses on the UGS provided by government. Constraints in most of the mechanisms are revealed, while some of the constraints are coherent with city context and difficult to be modified. It is recommended to empower the public as well as the private stakeholders into the provision of UGS through more innovative mechanisms, which could be the focus in later studies.

Urban fringe is targeted area in this study since it is an important land supply approach in growing cities, likely to be developed with adversely impact on ecological environment and has high potential to be green. However, whether this framework could be transformed to other kinds of development such as urban renewal, infilled development, etc. is doubted. To generalize the framework to other kinds of development cases, more studies are required. As some growing cities may change to shrinking cities in future, the mechanism of UGS provision in inner-city development will draw more and more attention.

MD is applied in UGS provision and comparative study. More empirical studies may be required to verify the application of the theory, as such research will help the better allocation of land resources. Incentives are proposed to improve the implementation of a good land use plan. Details of the incentive design and the practicality of the mechanism need further exploration.

APPENDICES

Appendix A: Interview questions and answers from the interviewees

(extracted from the interviews and replied emails)

Q1: How did the project or the planning process work (from beginning to now)?

A2 ***(HDN - Planning Department)*****:** The planning of Beijing consists of four levels. The first level is the master planning, including the plans of new towns. Under the master plan is the second-level block plan. E.g. Haidian District, used to be central city, is under control according to block plan. After block plan is the deepening scheme of block (level 3) and then the regulatory detailed plan (level 4). The block plan is to control a certain range of area like a large group, dealing with the main functions, how much land for construction, how many buildings to build and the how to provide public service facilities. These questions identified in block level planning are in relatively large-scale and structural. Then there is a basic layout of land in the block plan, but the layout is not regulatory, and the regulatory part is determined by the amount of construction and those control indexes. In the next level of regulatory detailed plan, the control indexes of the block are elaborated and divided to each land plot, and the regulatory detailed plan will be complied before the land comes into the land market for trade and development. Therefore, the regulatory detailed plan is very important due to the land control rules it established, which are all control indicators.

The background of this plan (block-level plan in Haidian North) is rather complicated. From the perspective of hierarchy, it is a block plan guided by the upper-level master plan. But there is also a previous version of plan which is called the Regulatory Detailed Plan of New Towns in Haidian North (HDN), which is in parallel with this block plan in in terms of hierarchy. So this block-level plan is compiled on the basis of control rules of the previous planning, to improve it by including other aspects such as the layout and to expand the amount of development, formatting the block-level and regulatory detailed planning of HDN. The aim of this plan is mainly to solve the problem of industrial land use, together with the transformation of the village, the protection of the green ecological corridor, and the spatial coordination. The core of the plan, though not explicitly stated, was to solve the problems of the industry land use.

A3 ***(Seestadt - Wien 3420 Development Company)*****:** A competition was held to choose the best plan. During the competition, there's a jury consisting of government, and some experts from

architecture and city planning, and they try to find the best project. It’s an ideal way, a dialogue between government and experts.

A4 ***(Bushwick - Planning Department)*****:** In Bushwick there was a community board. The community boards which are in each neighborhood are local, governing bodies appointed by president's office and they make decisions about land use issues and other major community issues. They’re fifty-nine of them in the city in sum. The members are local residents and so. They often take the lead in neighborhoods, and their voices are strong.

The Bushwick community board sent a letter, to the council members, actually in the area requesting that there be a study of a Bushwick, because there is a lot of new development happening on side streets, like tall buildings. And so, the current zoning of the district that is basically in the entire study area allows for this sort of scale development to happen, sort of towers in the park, the towers that face the street. That was like a huge concern. Bushwick was just experiencing a lot of development pressure right now so it's an area where there's like really a real estate market, a major big arts community. On the borders of this area over here, Williamsburg, that has been a major arts centre here and there's basically coming east from Williamsburg which is an area that was rezoned in the early two thousand, like a waterfront area where there's been a ton of new development and sort of development pressure has just been moving east to Bushwick along this train line, the L train. That has been a challenge and disruptive for a lot of residents in Bushwick because all this development pressure has led rising rents. This led to gentrification and displaced men and people haven't been able to stay in their apartments in their homes.

A mix of those folks were involved in the planning process. The community sent a letter to the council members, requesting that a study be done here and then the council members started this community planning process, and without the city (government) stakeholders together formed a steering committee. The committee started doing from these smaller requests to outreach and advance where they find out what people want to see in the future and then they brought the city on board. We've now been working more like a partnership, but we basically came in to help them think about and make sure that new development is like the right scale. We were working with the steering committee that's comprised of the community board which is like a local governing body represents local organizations and residents. I think the steering committee thinks community planning means community led planning; so, community as opposed to the city is the group of local stakeholders leading the process and the city is sort of supporting that, which is more or less the process that's happening right now in Bushwick. Like

we're working in partnership with this steering committee which has its structure and they can vote, make recommendations, etc., and providing them with all of the data and information they need to facilitate their process.

Q2: How did the public participate in the planning process?

A1 *(HSK - Planning Department)*: The Study commissioned by the Civil Engineering and Development Department (CEDD) and Planning Department (PlanD) in 2011. In order to incorporate public views into the planning and design of the NDA by formulating a feasible land use framework, three stages of community engagements have been organised. During June to September 2015, the Stage 3 Community Engagement (CE3) was undertaken to seek public views on the Recommended Outline Development Plan (RODP) for the HSK NDA. During the consultation period, various formal briefings / meetings were organized for statutory and advisory bodies including Town Planning Board, District Councils, Legislative Council as well as relevant professional institutes. Various local stakeholders /residents /concerned groups/green groups were also consulted. Besides, a public forum was held on 8 August 2015 to gather public views on the proposal of HSK NDA. More than 1,000 public comments were received during CE3.

A4 *(Bushwick - Councillor)*: We wanted the community residents that came his process from all different places like community members, members of block associations, just people who participate with the local community-based organizations be educated about the language of planning before they really diving in. I think the planning process here especially in New York is designed to keep people out of decision making by being very complicated. And so, we had some tools created by a local organization to try to help translate all these things for a more general audience they have. The toolkit called “what is zoning” is basically like a board with big Legos, and they taught people through how the zoning effects, what a building looks like and also the uses. On one side of the board was like a community on it, and then the other side is the block level was like how to build a building and what are the different restrictions. It really gets people sort of familiarize with how zoning works, and they have had a similar one for affordable housing that explains what the regulations are. So, we started out like an education tool went around to all these different organizations and groups in the neighbourhood and did these workshops with them, just to get them up to speak. Then after that we started the listening sessions in town hall meetings like what are your visions for the neighbourhood, what do you want to see, as far as not only the buildings and zoning but parks and open space and

transportation, all these things that we are talking about now. As we brought out the agencies, the process became more formal and we put together the steering committee. The steering committee elected its executive committee and formed the subcommittees and stuff them. I think the staff role for our office has really just been this whole time facilitating this process, making sure that all these things happen, making sure the meetings are staffed, making sure someone taking notes, making sure there's a website, making sure the website is updated, etc.

Q3: Is there any standard/target for green space provision in this project?

A1 ***(HSK - Planning Department)*****:** In planning the recreational, open spaces and greening land uses, we have making reference to the principles and guidelines on greening as provided in the Hong Kong Planning Standards and Guidelines (HKPSG), and other relevant studies are available in the public domain.
(link: http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/full/ch4/ch4_text.htm)

A2 ***(HDN - Planning Department)*****:** Green space in the planning of the next level is actually a rigid control index, which could not be reduced from the upper level and could be more but not less. As long as the green land reduced, basically it is difficult for the plan to get approval. The HDN plan is sure to reach the standard, such as the two indicators of green coverage rate and the area of green space per capita. These are not many people living in this area, so the indicator per capita would certainly be satisfied. Once the bottom line of greenery is established in the upper level of plan, the lower level plan will just follow it, putting the control indexes into implementation.

A4 ***(Bushwick - Parks Department)*****:** The areas in yellow (in the map of Bushwick showed during interview) are the areas where people are within walking distance from a park, in ten minutes to a park or playground. And that are sort of our guiding approaches and we've been targeting these areas. So, there are mostly industrial not residential uses, and public spaces are what we don't have as many. This’s a big gap here, but we have been targeting these areas.

Q4: How public green spaces/open spaces are planned and provided in this project?

A1 ***(HSK - Planning Department)*****:** In different stages of the Study, due considerations have been given to set up the vision, positioning, guiding principles for HSK NDA. Based on these principles, the planning concept and urban design framework had been established for the HSK NDA in order to create a green city; foster economic vibrancy and employment; integrate leisure space with natural, cultural and landscape resources; and optimise transport infrastructure and improve mobility. Based on which, development parameters and land use

budget for the RODP have been formulated. Detailed information of the planning concepts, urban design framework, land use proposal and/or feature highlights for the HSK NDA are available in the relevant engagement digests of different stages in the Study's website (link: http://www.hsknda.gov.hk/). You can also access the engagement reports in the Study's website regarding public comments received and our responses to stakeholders on different concerned issues. The RODP is being revised taking into account of the public comments received during CE3, advices from relevant government departments as well as planning and engineering considerations and technical assessments. An Environmental Impact Assessment (EIA) under the EIA Ordinance is being carried out in order to consolidate the results of various environmental assessments. Appropriate mitigation measures will be proposed to avoid adverse environmental impacts.

A2 ***(HDN - Planning Department)*****:** UGS is provided according to the set of indicators of facilities and infrastructures. There is a standard manual in Beijing regulated how much UGS and how many areas of UGS per capita should be provided. All kinds of infrastructures and facilities are provided in accordance with the standard. The controlled indicator of the plan is the total amount of construction land, and other indicators such as those for UGS will just follow the standard. For example, if the scale of construction land exceeds/increases 10 km^2 in a plan, relevant requirements of facilities and infrastructures must be provided based on the regulated standard and in accordance with the increase of 10 km^2 construction land.

A3 ***(Seestadt - Wien 3420 Development Company)*****:** Normally in those city development processes is the government decide everything, but our existence – WIEN 3420 is not common. We can find funds from the EU, and the city could not. For the central park, the sea park, we had the EU funds to use and the city of Vienna could not apply for those funds. So, we had to apply for them, together with another agency, which makes the construction quite complex. But in a way it's good for us, because we exist, and we can make sure that the level of the quality is good here. Another thing that we exist is that we can sell the plots, easier than the government. Before we develop the land, the land belonged to the governments, and they sold them to another company which is somehow part of the municipality. We are selling the plots for this municipal-owned company, and with the money we get we invest the public space by half. So, fifty percent of public spaces are paid by us with the money that get from selling the plots and only the other half is paid by the government. This model is really working well, because we are more independent, and we can invest more money than the government could. After development, the parks are given to government. We don't want to have it which will cost

more money to maintain and to manage.

The large proportion of open spaces will influence the value of the project, and that's what we want. We want to raise the value of the plots by building the infrastructure and the high quality open space that somehow, we want the inhabitants to feel good to live here and like here. But we also want to sell the plots more efficiently to get the money back. There are some blocks in this project are planned for affordable housing, and some are planned for public housing which will be owned by government and people pay the rent to government, a special model in Vienna.

A4 ***(Bushwick - Parks Department)*****:** How we're approaching that and how we're choosing to a better approach is to the first acquire land or to improve or to extend the existing parts, or we've been partnering with other agencies like schools, schools which have playgrounds and form a partnership with the schools. If they allow that after school hours to open up the property to the public, Parks will also help maintain those safe. There's also another approach that we are buying land through acquisition, trying to buy land to create new parks, but that one is more difficult. Here is in very severe shortage of housing too, and, so trying to take away of housing that occupied is difficult. Or looking at city owned land already, there are opportunities to use that for new open space.

This land here (in the map of Bushwick showed during interview) is going to be a new park. It just would be passive. And so, when they had a new development that was built in exchange for increased density, they had to build a new park. So, this is the pockets haven't been developed but it will be a small playground and the plaza and seating area. The Parks don’t need to buy the land, because it was an exchange for a higher density. So, it was part of their obligation to the city -- was to build a park. And, because there will be new residents, they need to provide more open space since they do such a large development.

In the Bushwick plan, there are some parks reconstructed and new parks added. However, those are political decision I can’t make. In theory, yes. In practice, that’s not how it always works. There’s difference between theory and practice. We can give the suggestions and we do. But that’s not what really influences it, excepting get the money. What generally happens is we take that information from public. Because we are in the face that we don’t have any money and we are still in the privacy. It will largely be we can make a recommendation and say, all right, this is where the investment has been made. These works have been done. And it will take that to the elected officials. So, this process right now is different from how we traditionally do things, because it’s larger multiple agency planning efforts. Normally each

agency does their own planning and has their own priorities and the areas that they target. So, this is the coordinated efforts with other agencies as well. We are working, and we are don't normally do this, working with department vocation, department transportation, housing, natural, etc. All city agencies are sitting at the table to talk immediately the planning which is something that does not typically happen. These agencies do their own things, separate parts, and we don't always communicate. So, the idea is that we all communicated and talked, knowing who is doing what, where and when, so that we can coordinate even just do in a sheet. Like we have a project detail and we do this part, or we just wait or just do straight until we were done. Simple coordinating thing is like that. The public opinion will be collected and submitted to the office, but we are not sure whether it could be taken to practice. It just like to link or convey this information between people parties and agencies, from public to government. But it is still the government makes the final decision, and it often be elected officials who gives the money. It depends on the funding. We have that the process that we go through, but in the end, there is sort of decided at the last minute between the mayor and city council negotiating back and forth. The best help for communicated voices mayor or officials that represent is like they take people's concern as their consideration.

Q5: What do residents want from this project?

A2 ***(HDN - Planning Department)*****:** Local farmers have the requirements of housing demolition and resettlement. However, although the development of HDN tends to transfer rural farmers to urban residents which is being processed, it seems difficult to implement. The current trend of construction is to keep some villages as they are and protect the characteristic of rural areas. The rural lands are likely to be retained with in situ modification. So, the real starting point of this plan is to create enough land and space for Haidian to conduct industrial development. This is a fundamental and forward-looking consideration with some forward-looking measures, rather than a reflection of the market at that time.

A4 ***(Bushwick - Planning Department)*****:** First is that the current zoning of the district allows for this sort of development to happen like tall buildings on side streets. The towers that face the street were a huge concern. And then the other really big issue is affordable housing or preserving and creating affordable housing in Bushwick, one of the major request has been marked, rehiring a new policy New York City brought last year that actually requires that growth areas to provide a certain percentage of new development for affordable housing. (-What do you mean by the affordable housing, same as the public or social housing?) No. There

is a lot of public housing highly in the centre of Bushwick and a little different from other buildings. The affordable housing actually is usually set within market rate building, but it just will be a certain percentage. Then we also do have affordable housing that would be a new building where it's hundred percent affordable, but it is managed by a nonprofit local partners. So, it would be hundred percent affordable made with subsidies to the developers with regular agreements, locked in like thirty years of affordability, but the city in the same time said they don't own it.

Q6: What do you think are the difficulties in your work (or in the project)?

A1 ***(HSK - District Councillor)*****:** There are many social issues in the development of HSK. We do want to develop, but if it's going to happen, many things should be well balanced. The balance among government, villagers, village heads, district councillors, chairmen of the village, as well as green groups, is the most important point. Our district council is actually playing a consulting role, which is a bridge between the government and the villagers, and also a bridge between the government and the environmental groups. If environmental groups talk directly to the government, they will not care about the villagers and the district councillors. But, with us, they could coordinate with the villagers. These environmental groups should know how the villagers feel or the feelings of those who set themselves on fire. We (they) can't only focus on our (their) own requirements.

A2 ***(HDN - Planning Department)*****:** The arrangement of the layout is not difficult. The difficulty is how to account the construction land index, to clarify where the new construction land comes from. The calculation is very complex. We have to know how to break through the control in upper level plan and increase the controlled quota of construction land in HDN. What we have done in this plan is to integrate farmers' land, the rural residence land and rural industrial land, by entirely demolition, after which the land is tied to the industry land and construction land in market. It is called collective industry land, a special policy of Beijing. Collective industry land is rural land belonging to collective organizations, but after integration it could be accounted as the quota of construction land.

A4 ***(Bushwick - Planning Department)*****:** The hardest thing is trying to address what the community once required within the constraints, because there's a lot that they want that we just can't do either for lack of resources or we don't have the money. I think the biggest challenge of our job it not to internally create a very pretty plan. We can do that very quickly. But if there is no community support for it, there is no path forward. And so, much of our

process is just felt like getting community success and support like building that consensus, leading up to a proposal, etc. and that takes a lot of time.

Appendix B: Sample questionnaire for resident surveys

Investigation on the desires of the local residents for the xxx plan

Dear Sir/Madam, hello! We are students from xxx, and we do research on urban planning. Now, we want to some survey about residents' needs in urban development, which is about which kind of land uses you need and how much you need them. You are invited to participant in the survey and fill in the questionnaire. Your supports are highly appreciated.

1. Do you know the land use plan of …? （please tick"√"） □ Yes □No

2. How did you participate in the planning and development process? （please tick"√"）

□Never participated □Attended public forum □Attended consultation meetings □Emailed to developer or government □Went to the service centre of project □Others_____

3. In the future development of …, do you have following needs? How much do you need them?

(Please tick at the corresponding cells, where *1-Don't need it, 2- Slightly need it, 3-Averagely need it, 4-Really need it, 5-Need it very much*)

（1）Housing

		Don't need	Slightly need	Averagely need	Really need	Deeply need
1.1	I need to live in this district after development	1	2	3	4	5
1.2	I need social housing	1	2	3	4	5
1.3	The categories of houses should be diversified	1	2	3	4	5
1.4	The density should be proper	1	2	3	4	5
	Others (please fill in you other needs in housing)					

Are you satisfied with your current residence?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

Are you satisfied with future residence planning?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

（2）Industry

		Don't need	Slightly need	Averagely need	Really need	Deeply need
2.1	I need agriculture in this district	1	2	3	4	5
2.2	I need industries in this district	1	2	3	4	5
2.3	No pollution from industries here, if there are industries	1	2	3	4	5
2.4	I need high-technology industries	1	2	3	4	5
2.5	I need commercial facilities and services	1	2	3	4	5
2.6	I need more and diversified commercial services	1	2	3	4	5

	Others (please fill in you other needs in industry)

Are you satisfied with the current Industry?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

Are you satisfied with future Industry planning?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

（3）Environment

		Don't need	Slightly need	Avera gely need	Really need	Deeply need
3.1	Current green space should not be destroyed or reduced	1	2	3	4	5
3.2	I need to increase green spaces in this area	1	2	3	4	5
3.3	The water body should not be polluted	1	2	3	4	5
3.4	Vegetation should be well maintained	1	2	3	4	5
3.5	Park should be accessible through walking (within 1km distance)	1	2	3	4	5
3.6	Other public spaces are accessible through walking	1	2	3	4	5
3.7	Facilities in public space are complete	1	2	3	4	5
3.8	I need ecotourism	1	2	3	4	5
3.9	I need clean energy (e.g. solar, wind, etc.)	1	2	3	4	5
3.10	Garbage are recycled	1	2	3	4	5
	Others (please fill in you other needs in environment)					

Are you satisfied with your current living environment?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

Are you satisfied with future environment planning?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

What do you think is the reasonable percentage of green space?

□<10% □10~20% □20~30% □30~40% □40~50% □50~60% □>60%

Do you want to (are you willing to) pay more money for better landscape and living quality?

□Absolutely no □no □ maybe □yes □absolutely yes

（4）Transportation

		Don't need	Slightly need	Averagely need	Really need	Deeply need
4.1	I need more roads	1	2	3	4	5
4.2	I need more public transport	1	2	3	4	5
4.3	Bus station should be accessible through walking (within 1km distance)	1	2	3	4	5
4.4	Metro station accessible through walking	1	2	3	4	5
4.5	Pedestrian should be well designed and safe	1	2	3	4	5
4.6	Public transport should be environmental friendly (e.g. electricity tram)	1	2	3	4	5
4.7	I need lanes for bicycle	1	2	3	4	5
	Others (please fill in you other needs in Transportation)					

Are you satisfied with the current Transportation?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

Are you satisfied with future Transportation planning?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

（5）Facility and Culture

		Don't need	Slightly need	Averagely need	Really need	Deeply need
5.1	The original cultural elements in this region should be preserved	1	2	3	4	5
5.2	Infrastructure should be complete	1	2	3	4	5
5.3	Entertainment and leisure facilities should be complete	1	2	3	4	5
5.4	I need community service	1	2	3	4	5
5.5	I need hospital in this region	1	2	3	4	5
5.6	I need primary and junior school in this region	1	2	3	4	5
5.7	I need professional education institute in this region	1	2	3	4	5
5.8	Public security should be good	1	2	3	4	5
	Others (please fill in you other needs in Facility and Culture)					

Are you satisfied with the current Facility?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

Are you satisfied with future Facility planning?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

（6）In summary, are you satisfied with the planning of this region?

□Very dissatisfied □dissatisfied □average □satisfied □very satisfied

4. Among the following 8 land use categories, which do you think is more important?

Please sort them, and write its No. on the lines "____".

①Agriculture ②Industrial ③Commercial ④Residential ⑤Transportation ⑥Green space ⑦Infrastructure ⑧Facilities

_____, _____, _____, _____, _____, _____, _____, _____.（Write the No. of the most important land category at the first, sorting them by their importance to you）

5. Your basic information

Gender： □ Male □Female

Age：□<10 □10~20 □20~30 □30~40 □40~50 □>50 years

Do you live in this region now? □Yes □No

How long have you been here? □…

Education level: □…

Monthly income: □…

Thank you very much!

Appendix C: Glossary of acronyms

Acronym	Definition
ABM	Agent-based Modelling, a quantitative research method for simulating how multiple agents interact to make decisions in urban planning and development based on their utilities.
ABM-CA	Agent-based Cellular Automation Modelling, a quantitative research method for simulating how multiple agents interact with the spatial features and environment (represented in land cells) to make decisions in urban planning and development based on their utilities.
DO	District Open Space, medium scale open space in urban areas or at urban fringes to serve district population.
HDN	The case of Haidian North planning in Beijing, one of the four selected cases in this study.
HK	The city of Hong Kong, officially the Hong Kong Special Administrative Region of the People's Republic of China.
HSK	The case of Hung Shui Kiu planning in Hong Kong, one of the four selected cases in this study.
LO	Local Open Space, relatively small-scale open space in urban areas or at urban fringes to serve local population.
LSD	Least Significant Difference, the value to determine the difference between two varietal means for a characteristic at a particular level of statistical probability.
MD	Mechanism Design, an economic theory focusing on designing rules of gaming to achieve an expected outcome.
NDA	New Development Area in Hong Kong.
NYC	New York City in the United States.
OS	Open space, including regional, district and local open space in urban areas. It is sometimes separately analysed in the model from other green spaces.
PR	Plot Ratio, which equals to the gross floor areas of the building dividing the total area of the site.
R_g	The percentage green space of the total area in a studied case.
RO	Regional Open Space, large scale open space in urban areas or at urban fringes to serve territorial population and tourists.
UGS	Urban Green Space, defined as public green area in urban development that is partially excludable and congestible. It includes open space, parks, green belt, amenity areas, conservation area, playground, lakesides, etc.
WTP	Willingness to pay for lands or houses that have higher prices due to their closeness to urban green space.

Appendix D: List of publications

The following is a list of publications and participated conferences containing the work presented in this thesis as well as some additional results.

Journal Article

1. Edwin H. W. Chan, Anqi Wang, and Wei Lang (2016). Comprehensive Evaluation Framework for Sustainable Land Use: Case Study of Hong Kong in 2000–2010. Journal of Urban Planning and Development, Vol. 142(4). Doi: 10.1061/(asce)up.1943-5444.0000346

2. 容晓君, 孙瑶, 王安琪, 陈汉云 (2017). 香港历史遗产活化更新的商业模式探讨. 国际城市规划, 32(03), 42-49. (English Title: Different Business Models for Adaptive Reuse of Heritage Conservation in Hong Kong)

Article under review

3. Anqi Wang, Edwin Chan. Institutional Factors Affecting Urban Green Space (UGS) Provision - From Local Government Revenue Perspective. Journal of Environmental Planning and Management (under review after revision).

4. Anqi Wang, Edwin Chan. The Impact of Urban Greening Power-Geometry in Participatory Planning. Urban Forestry & Urban Greening (under review).

Conference Paper

4. Anqi WANG, Edwin CHAN, Stanley YEUNG (2017). A Framework for Conservation Construction Plan Model (CCPM)." Procedia Engineering 196: 816-821. https://doi.org/10.1016/j.proeng.2017.08.012

5. A.Q. Wang, Edwin H.W. Chan, Stanley C.W. Yeung, J.B. Han (2017). Urban fringe land use transitions in Hong Kong: from new towns to new development areas. Procedia Engineering 198: 707-719. https://doi.org/10.1016/j.proeng.2017.07.122

6. Anqi WANG, Stanley YEUNG, Edwin CHAN (2016). Comparison of growth management policies in America and China. 53rd International Making Cities Livable Conference, Rome, Italy, Jun. 13-17. (The eConference paper available online at http://www.livablecities.org/)

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7. Anqi Wang, Edwin Chan (2018). Designing Incentive-compatible Mechanisms with Agent-based Model to Improve Public Welfare in Green Neighbourhood Planning Symposium on Applied Urban Modelling (AUM). Robinson College, University of Cambridge, UK, Jun. 27– 20, 2018. (Abstract with presentation)
8. Edwin Chan and Anqi Wang (2017). Urban Land Use Research: Land-Use Planning Scenarios and Socio-Economic Considerations. RISUD Annual International Symposium on New Frontiers in Urban Development, Hong Kong, Aug. 24 -25. (Abstract with presentation)
9. Anqi Wang, Edwin Chan, Stanley Yeung (2017). A land use planning model for green space allocation considering the amenity value. 2017 AAG Annual Meeting, Boston, Massachusetts, Apr. 5-9, 2017. (Abstract with presentation)
10. Anqi Wang, Martin Heintel, Edwin Chan, Stanley Yeung (2016). Achievements and challenges of wide urban open space supply in expanding Vienna. Regional Studies Association Winter Conference 2016: New Pressures on Cities and Regions, London, UK, Nov. 24-25, 2016. (Abstract with presentation)

Appendix E: Author biography

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