A COUNTRY PROFILE OF THE LAND ADMINISTRATION DOMAIN MODEL FOR CHINA - WITH A FOCUS ON LAND AND HOUSING INTEGRATION

YUEFEI ZHUO
Enschede, the Netherlands,
March, 2013

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Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of University of Twente in partial fulfilment of the requirements for the degree of Master of Science in Geo-Information Science and Earth Observation.
Specialization: Land Administration

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ABSTRACT

Land and housing are not only the basis for the existence and development of human but also important guarantees for the economic development and social stability, especially in urban areas. Due to their mutually dependent existence in reality, the transfer or mortgage of housing would also require the transfer or mortgage of its appurtenant land at the same time. As a result of the integrated natural property of land and housing, the certificate of housing and land could not be isolated and should provide a uniform certification. Moreover, from the legal perspective, a number of provisions have formulated that it is necessary to introduce an integrated mechanism for land and housing management, especially for the registration issue.

However, in most regions of China, land and housing are still managed by two different departments, namely the MLR and the MOHURD. Such separate modes of land and housing bring about inconveniences for real estate development, transactions and also leads to a number of disadvantages in actual practices.

As for this integration problem, this thesis tries to solve it from the technical perspective. Meanwhile, according to the Land Administration Maturity Model (LAMM) which was introduced by Prof. Peter van Oosterom, this research attempts to solve the problem at the standardization stage. Thus, the principle of Land Administration Domain Model (LADM) – ISO standard 19152 is introduced then. Based on this basic knowledge, the design task of LADM country profile for China is carried out. Specifically, this task can be divided into three main phases: analysis of required and current structure for land and housing database in China, design of the LADM country profile for China based on these analysis results and the evaluation of this country profile.

Specifically, first of all, on the basis of related laws and regulations, a series of legal requirements for the integrated mechanism for land and housing management in China is collected. Then, the current structure for land and housing database is studied by referring the SULBRD standard, which takes the Chongqing Municipality for example. Next, based on these two analysis outputs, the country profile for China is developed in accordance with the LADM standard. Finally, in order to evaluate this country profile, an evaluation framework is established. It generally consists of two main parts: on one hand, the requirements verification is to verify the achievement of legal requirements collected in the analysis stage. On the other hand, the abstract test suite is carried out to examine the compliance of the country profile for China.

Following the procedure above, a LADM country profile for China is designed. As for this country profile, its foundations are relevant legal requirements collected from related laws and regulations and the SULBRD. Considering the focus of this research, the integrated structure for land and housing database is one of key features in the country profile. Moreover, within this country profile, any key feature is that it covers the domain of both land and housing management of China in general.

Key Words: Land and Housing Database Integration, Legal Requirements, LADM Country Profile China

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Yuefei Zhuo

Enschede, the Netherlands

Feb 2013

-- To my parents

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ABBREVIATIONS AND ACCRONYMS

AQSIQ:	General Administration of Quality Supervision Inspection and Quarantine of the People's Republic of China
ATS:	Abstract Test Suite
BLRH:	Bureau of Land Resources and Housing
CCDM:	Core Cadastral Domain Model
CFR:	Chinese Fiscal Revenue
CLIS:	Cyprus Land Information System
CP:	Control Point
DEM:	Digital Elevation Model
DOM:	Digital Orthophoto Map
DRG:	Digital Raster Graphic
EA:	Enterprise Architect
FAO:	Food and Agriculture Organization
FDM:	Federated Data Model
FIG:	International Federation of Surveyors
FLOSS:	Free/Libre Open Source Software
GCS:	Geodetic Coordinate System
GDP:	Gross Domestic Product
GPS:	Global Positioning System
IC:	Identity Certificate
INSPIRE:	Infrastructure for Spatial Information in the European Community
ISO:	International Organization for Standardization
KKR:	Cross-Reference Register
LADM:	Land Administration Domain Model
LAMM:	Land Administration Maturity Model
LAS:	Land Administration System
LHCD:	Land and Housing Cadastral Database
LPC:	Local People’s Congresses
LR:	Legal Representative
MDA:	Model-driven Architecture
MHWST:	Mean High Water Spring Tide
MLR:	Ministry of Land and Resources
MOBR:	Measures of Building Registration
MOHURD:	Ministry of Housing and Urban-Rural Development
MOLR:	Measures of Land Registration
MPC:	Multi-Purpose Cadastre
NPC:	National People’s Congress
PL:	Property Law of the People's Republic of China
REAL:	Law of the People's Republic of China on Urban Real Estate Administration
RLAPs:	Relative Location of Adjoining Parcels
RRRs:	Rights, Restrictions, and Responsibilities
SAC:	Standardization Administration of the People's Republic of China
SBSM:	National Administration of Surveying, Mapping and Geoinformation

SDI:	Spatial Data Infrastructure
SIGIT:	Sistema de Información Gestion Integral de Tierras
SoHO:	Housing Ownership
SoLT:	Subject of Land Tenure
STDM:	Social Tenure Domain Model
SUCD:	Standard for Urban Cadastral Database
SULBRD:	Standards for Urban Land and Building Register Database
UML:	Unified Modeling Language
WTO:	World Trade Organization

1. INTRODUCTION

1.1. Background

Land and housing are not only the basis for the existence and development of human but also important guarantees for the economic development and social stability, especially in urban areas (Y. Zeng, 2008). Since the 1970's liberalization in China, the demand for land and housing has increased. With increasing demand, the land and housing market is becoming an important growth point for China's economy. The Minstry of Finance (2011) shows that the income of land transfer accounted for around 60% in Chinese Fiscal Revenue (CFR) in 2011, and real estate transaction contributed about 6% of Gross Domestic Product (GDP) annually from 1990 to 2006 in China (Zhou, 2008). Land markets require an administration system and established rules (Williamson et al., 2010). For the prosperous Chinese real estate market, the management system of both land and housing is needed.

Moreover, from the perspective of legislations, with the promulgation of 'the Law of the People's Republic of China on Urban Real Estate Administration' (hereafter referred to as REAL) in 1994 and 'Property Law of the People's Republic of China' (hereafter referred to as PL) in 2007, the integrated registration of land and housing was issued formally as articles in laws. As far as these features, land and housing should not be separated.

However, in most areas of China, land and housing information issues are still separately managed by two different ministries: the Ministry of Land and Resources (MLR) and the Ministry of Housing and Urban-Rural Development (MOHURD). Nowadays, as for the management of land and housing, information only some relatively developed cities and provinces have realized the integration objective, such as Shanghai, Guangdong, Chongqing, etc. (Liu, 2007). For other areas, the departments of land and housing are still separately established (Y. Wang, 2006).

As is also stated by Williamson et al. (2010), one of the major problems with Land Administration System (LAS) design is the isolation of various components and agencies. This leads to the problem of 'silos'. And the most promising solution to the silo problem is data integration (Gardner, 2005). Thus, for solving the existing silo between land and housing agencies, the integration of them shall be the emphasis then.

Van Oosterom et al. (2009) introduced the Land Administration Maturity Model (LAMM) and its related four levels: standards, connectivity, integration and network, which is shown in Figure 1-1. According to this model, standards are the basic needs for the connectivity and integration among different organizations and agencies. And no level can be omitted as the subsequent level builds on the previous one. This leads to the initial role of standardization for data integration. However, as is presented above, in China, land and housing databases are still separately managed by two different departments. The ranges and types of land and housing data are varied and complex. In order to achieve the integration goal, standardization is becoming essential for this domain.

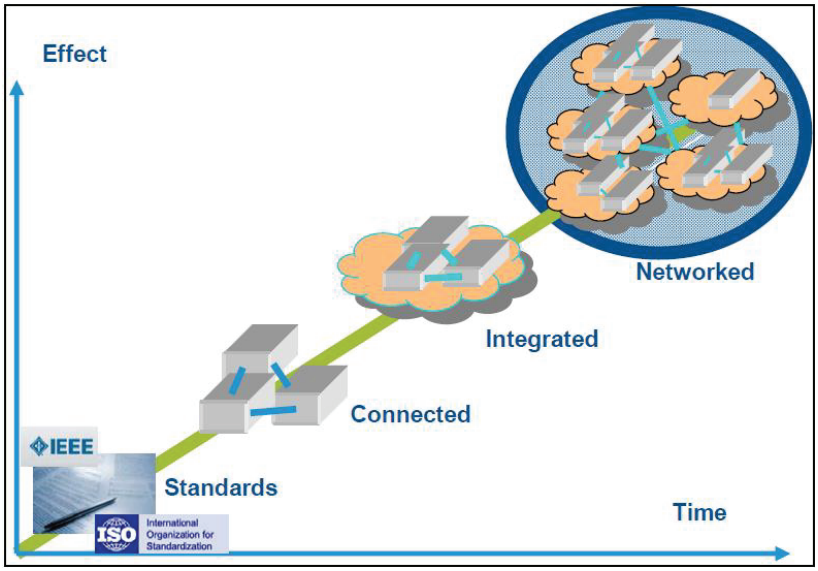

Figure 1-1 Land Administration Maturity Model (in Van Oosterom et al. (2009))

To face this theme, the Land Administration Domain Model (LADM) seems as a promising tool. The need for LADM [1] was launched at the International Federation of Surveyors (FIG) Congress in Washington D.C. in 2002, introduced by C. H. J. Lemmen and Van Oosterom (2002). It defines a conceptual model covering basic components of land administration (ISO/TC211, 2012), and functions as the standardization role for the connection and integration of different agencies (Van Oosterom et al., 2009).

Putting this all together, this research is to develop the LADM country profile China, with a focus on solving the integration problem of land and housing databases. The basis of this design will be the current structure for land and housing database and requirements from related legislations. Meanwhile, these requirements and the compliancy of the country profile will be evaluated ultimately.

1.2. Research Problem

Both land and housing data should be clear and delivered in a consistent way to reduce confusion for users (e.g. buyers/sellers in both land and housing market) (Simpson, 1976; Williamson et al., 2010). Moreover, according to related legislations in China, such as the REAL and PL, the land and housing departments involving their databases should be integrated. However, currently, in most areas of China, these two departments are separately established.

As the key affairs for the management of land and housing, registrations of land and housing are separately directed too. Land registration is in charge of the MLR, and its operation is in accordance with "Measures of Land Registration (MOLR)". While housing data is recorded in the MOHURD which is based on the "Measures of Building Registration (MOBR)". Such separation leads to problems like tenure insecurity, information provision, decision support, etc. (Y. Wang, 2006). All in all, these problems require more attentions on the integration of land and housing databases.

As is proposed in ISO/TC211 (2012), the LADM is defined as a reference model for land administration. And one of its features is to enable the combination of land administration information from different sources in a coherent manner. According to such feature, it is necessary to introduce the LADM-based data model as a promising solution.

In summary:

- *In China, data and processes related to land and housing are separately managed. Overall, this current situation impedes provision of land information, tenure security and land development activities. Meanwhile, such separation is not in keeping with the articles of relevant laws and regulations, such as the REAL, PL, etc.*

1.3. Research Objectives and Questions

In order to make the service of land and housing market more efficient and to strengthen tenure security on real estate objects, this research designs a promising model for the integrated management of land and housing registration that satisfies the requirements of related legislations.

The main objective of the research is:

- To analyse, design and evaluate a LADM country profile for China as a basis for reorganizing China's land and housing data in an integrated fashion.

Here, the LADM provides an abstract, conceptual model covering basic information-related components of land administration (ISO/TC211, 2012). Land and housing data refers to land cadastral data and housing cadastral data which are collected, stored and managed by the MLR and the MOHURD respectively. And the integrated fashion means an integrated structure for the management of both land and housing database in China.

This objective is detailed into sub objectives in order to clarify the achievement of the main objective:

1) Analysis

- to analyse the legal requirements, and
- to analyse the current structure for land and housing database in China.

2) Design

1 A predecessor of LADM was called the 'Core Cadastral Domain Model (CCDM)'.

- to develop the LADM country profile China, with a focus on the integration of land and housing databases.

3) Evaluation

- to evaluate the LADM-based model through requirements verification, and
- to test the compliancy of the country profile through abstract test suite.

Based on the main objective and sub objectives, the following research questions are addressed.

1) **Analysis**

- Q1: What is the legal system in relation to land and housing administration in China?
- Q2: What are the legal requirements for modelling of land and housing information involved relevant legislations?
- Q3: What is the current structure for land and housing database in China?

2) D**esign**

- Q1: How can these legal requirements be transformed into the LADM classes?
- Q2: What are the comparison results between chosen classes of LADM and SULBRD[2]?
- Q3: What are relationships and multiplicities between classes derived from Q1 and Q2 in the design stage?

3) E**valuation**

- Q1: What are compositions of the evaluation framework?
- Q2: Does this country profile complete those legal requirements?
- Q3: Is this country profile conformant with the LADM in terms of package and level?

1.4. Research Hypothesis

This research proposes a hypothesis that:

- *LADM can be used to integrate housing and land databases, and potentially overcome the separation in data and processes regarding land and housing registration.*

1.5. Scope of the Research

This research's main area of focus is the integration of land and housing databases in China. Considering the limitation of time, the implementation phase will be eliminated and only urban areas will be covered. The rural and marine parts are outside the scope. Specifically, related legal documents will be used as the foundation of legal requirements. Regarding the current structure for land and housing database, a case study of Chongqing Municipality in China will be studied. Depending on legal requirements and current structure, this research will draw a generic picture of the LADM country profile for China.

2 The SULBRD refers to the Standards for Urban Land and Building Register Database in Chongqing Municipality.

1.6. Conceptual Framework

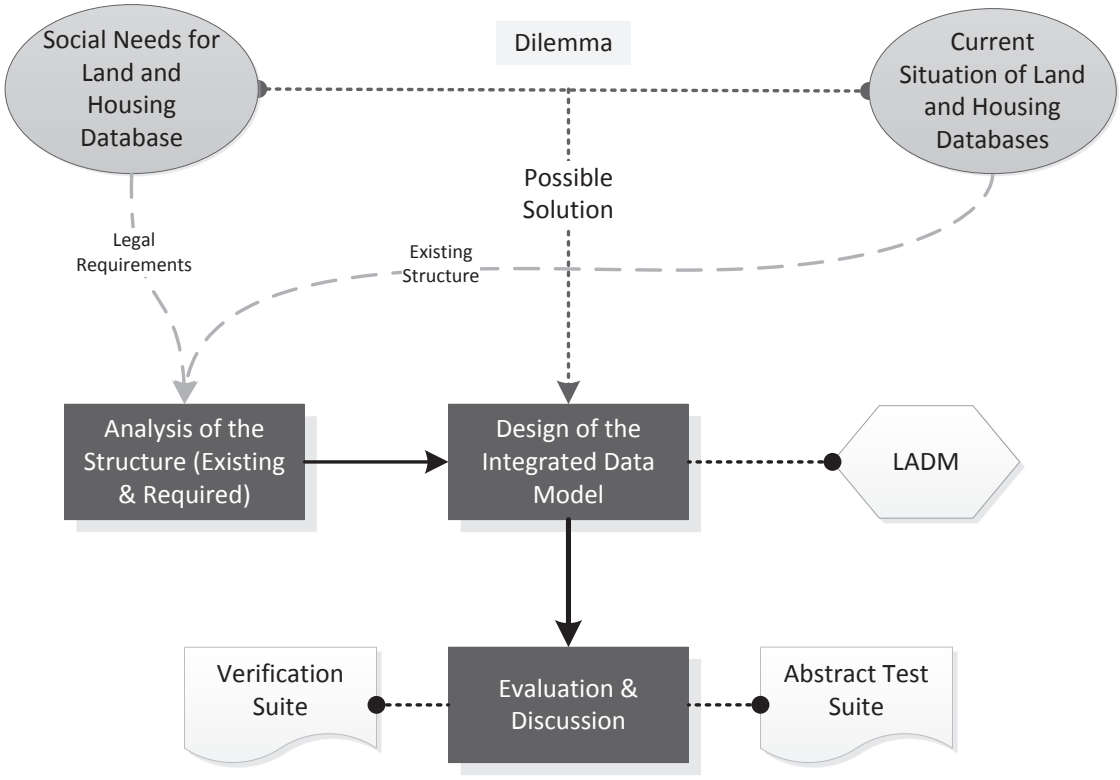

Figure 1-2 Conceptual Framework

First of all, there is a dilemma between social needs and current situation for land and housing databases in China. In other words, land and housing databases should be kept in a consistent way. That could support into improved collaboration between these two departments. Moreover, it is helpful to satisfy the legal needs for the integration of land and housing databases in China.

This research consists of three main parts: analysis, design and evaluation, as shown in Figure 1-2.

1) Investigating the current situation of land and housing database, and the legal requirements for this research through related laws and regulations, (*which will be detailed in chapter 4 and 5*)
2) Designing an integrated data model through the LADM standard, and (*which will be developed in chapter 6*)
3) Evaluating the achievement of these legal requirements, and the compliancy of the country profile China. (*which will be carried out in Chapter 7*)

The corresponding methods of each part are:

Specifically, firstly, the research will start from the analysis stage, which includes data model analysis and the collection of relevant legal requirements. Secondly, for the sake of the integration goal, an integrated land and housing data model will be developed based on the LADM International Standard. In the last stage, the main task is to evaluate the integrated data model through requirements verification suite, which are extracted from user requirements in the analysis stage, as well as the abstract test suite for the LADM compliancy examination of country profile for China.

For achieving these three main goals:

The adopted methods include literature review, synthesis, design and evaluation.

1.7. Research Methodology and Design

This research is typically a design research without fieldwork. As is claimed by Rossiter (2012), the research methods will be categorized into four main parts: system specification methods, system design methods, system implementation methods and system evaluation methods. Due to the limitation of time and resources, the implementation part will be outside the scope of this research.

The specific methods adopted for each part can be organized and described as below (See Table 1-1):

1) **System specification methods (Analysis):** in this phase, literature review, collection of user requirements and analysis of existing structure are three main tasks, so as to find out the existing and required structure for land and housing database. However, due to the lack of time, the research would only focus on the other two parts. For the data collection task, the SULBRD of Chongqing Municipality will be used as the main source so as to gain a clear idea of current situation of land and housing databases, and the requirements for the integration of land and housing databases will be mainly collected from related legislations.

2) **System design methods (Design):** This step is to develop a LADM-based data model for the country profile China in order to solve the integration problem. And the modelling method consists of the migration of chosen classes and the design of the country profile for China in accordance to the LADM standard.

3) **System evaluation methods (Evaluation):** in the third step, the main work is to evaluate the integrated data model through requirements verification, as well as the LADM abstract test suite for the compliancy of country profile. And such verification suite is mainly extracted from legal requirements in the analysis stage. Moreover, the abstract test suite will refer to the Annex A of the LADM standard.

Table 1-1 Research Design Matrix

Research Objective	**Main**	• To analyze, design and evaluate LADM country profile China as a solution for reorganizing China's land and housing data in an integrated fashion				
	Sub	*To analyse the legal requirements of this research*	*To analyse the current structure for land and housing database in China*	*To develop the LADM country profile China, with a focus on the integration of land and housing databases*	*To evaluate the LADM-based model through requirements verification*	*To test the compliancy of the country profile through abstract test suite*
Research Questions		1: What is the legal system in relation to land and housing administration in China? 2: What are the legal requirements for modelling of land and housing information involved relevant legislations? 3: What is the current structure for land and housing database in China?		1: How can these legal requirements be transformed into the LADM classes? 2: What are the comparison results between chosen classes of LADM and SULBRD? 3: What are relationships and multiplicities between classes derived from Q1 and Q2?	1: What are compositions of the evaluation framework? 2: Does this country profile complete those legal requirements? 3: Is this country profile conformant with the LADM in terms of package and level?	
Research Methods		• Literature Review • Synthesis		• Literature Review • Designing	• Literature Review • Evaluation	
Data Sources		• Literatures • Laws and regulations		• Literatures for the principle of LADM • Existing structures of land and housing database in Chongqing Municipality, China • Legal requirements for the integration of land and housing databases	• Literatures for the standard of LADM • Designed LADM-based integrated data model • Legal requirements for the integration of land and housing databases	

1.8. Thesis Structure

The structure of this thesis is organized as follow:

Chapter 1 – Introduction

This chapter gives an overview of the research, includes background, research problem, research objective, research question, research methodology and the structure of thesis.

Chapter 2 – Integration of Land and Housing Data: A Literature Review

This chapter reviews the background knowledge of land and housing databases, development of land and housing management in China and the principles of LADM, which will help in defining the concepts in the research. Desk research is the key approach in this chapter.

Chapter 3 – Research Methodology

This chapter presents the detailed plan of the whole research, including data collection, modelling and testing. The research strategy is formulated in line with the research approach, design and methods proposed in the first chapter.

Chapter 4 – Analysis of Legal Needs for the Integration of Land and Housing Databases in China

This chapter puts emphasis on the collection of legal requirements for the integration of land and housing databases. For this chapter, a number of related laws and regulations are selected. Then, by referring to these legislations, several articles are extracted. Finally, through the analysis of these related articles, the table with legal requirements is presented.

Chapter 5 – Analysis of the Existing Structure for Land and Housing Database in China: A Case Study of Chongqing Municipality

This chapter describes the current situation of land and housing database in China, based on a case study using the Chongqing municipality land and housing database. The SULBRD has been adopted to analyse the existing structure of the land and housing database. Moreover, the new existing data model of the integrated land and housing database is presented.

Chapter 6 – Design of LADM Country Profile for China

This chapter discusses the development of the integrated land and housing databases. By utilizing the data structure and legal requirements, the design of the LADM country profile is presented. The design steps are: migration of chosen classes and design of the country profile.

Chapter 7 – Evaluation of LADM-based Data Model

This chapter evaluates the integrated data model. It consists of two main parts: requirements verification and abstract test suite for the compliancy test of country profile. The verification suite is extracted from the legal requirements. Based on verification suite and abstract test suite, the achievement of legal requirements and the compliancy of country profile China are tested.

Chapter 8 – Conclusion and Recommendations

This chapter concludes the outcome of research, and provides recommendations for further research.

2. INTEGRATION OF LAND AND HOUSING DATA: A LITERATURE REVIEW

2.1. Introduction

The previous chapter introduced the background, research problem, objectives and questions, and the general methodology of the research.

This chapter will give a literature review on the integration of land and housing data, including basic concepts, historical development of land and housing management in China, needs for the integration of land and housing databases in China, a review of potential solutions for such integration and the principle of LAMM and LADM. Specifically, section 2.2 introduces the basic terms related to "people-land" relationship. Section 2.3 describes the historical development of land and housing information management in China, the current research status and needs for integration of them. Then, section 2.4 depicts the drawbacks and needs for the integration of land and housing databases in China. Finally, the review of potential solutions, and the principles of LAMM and LADM will be described in section 2.6.

2.2. Definitions

The definition of cadastre varies in different regions of the world throughout the different historical stages, as well as in China. As is stated by Henssen (1995), the traditional definition of cadastre is:

Cadastre is a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries. Such properties are systematically identified by means of some separate designation. The outlines of the property and the parcel identifier normally are shown on large-scale maps which, together with registers, may show for each separate property the nature, size, value and legal rights associated with the parcel.

As is stated by the FIG Commission 7 (1995), the cadastre is the primary means of providing information about property right. Specifically, the cadastre provides the private and public sector with:

- information identifying those people who have interests in parcels of land;
- information about those interests (e.g. nature and duration of Rights, Restrictions, and Responsibilities (RRR)), and
- information about parcels.

Furthermore, these three kinds of information can be graphically presented as the 'Subject-Right-Object' model (See Figure 2-1). The object in this model is land parcel.

Now, with the development of cadastre, Henssen (1995)'s definition must be enlarged to some extent. In UN-ECE (1996), cadastre is categorized into four types: juridical, fiscal, land-use and multi-purpose. The Multi-Purpose Cadastre (MPC) plays an important role in planning for sustainable development (Flynn & Johnson, 2003). Du et al. (1999) gave a definition of MPC in China:

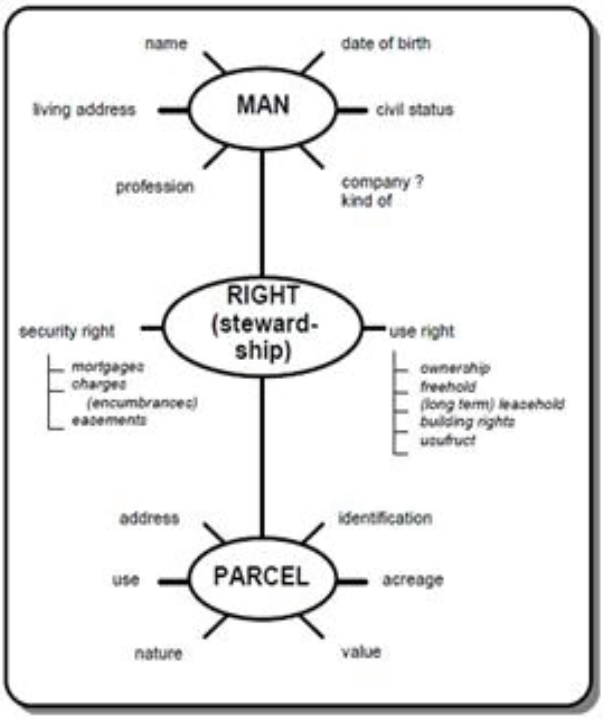

Figure 2-1 'Subject – Right – Object' Relationship (in Henssen (1995))

Cadastral is about the set of basic land information including the rights, position, quality, quantity and use of parcel-based land and its attachments, it is managed by the state with land rights at the core.

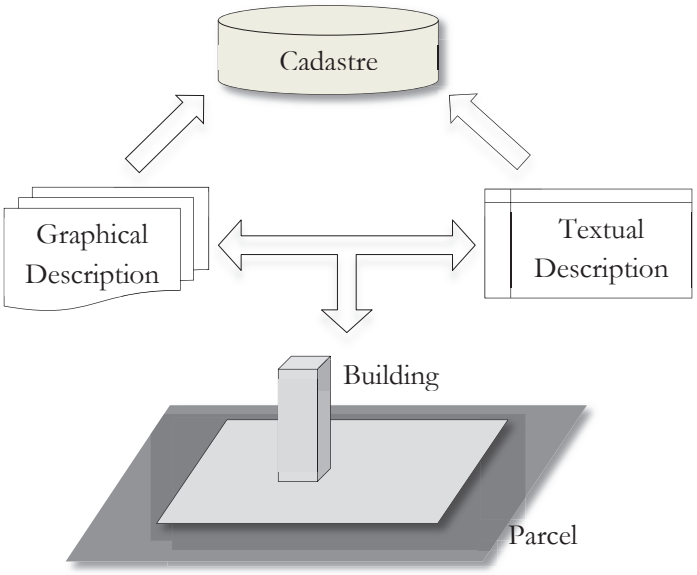

Figure 2-2 Relationship between Land, Attachments and Cadastre

According to the definition and its corresponding representation in Figure 2-2, the main object types in MPC in China are land and its attachments (which puts accent on land and its appurtenant buildings). While currently, these two object types are managed by two departments: the MLR and the MOHURD. Given this situation, the concepts of land cadastre and housing cadastre are introduced as follows.

Generally, within Chinese land administration domain, its necessary basis is cadastre (Ye, 2002), which will *Land Cadastre* instead for differentiating from the aforementioned concept of *Cadastre*. Lin et al. (2001) consider that land cadastre refers to the register book which records the land related information, such as location, boundary, quality, quantity, right, price, usage, etc. That means the main object for land administration is land and taking land parcel as basic unit. Therefore, its corresponding 'Subject – Right – Object' relationship is the same as the original one, which is shown as Figure 2-1.

Correspondingly, as for the housing administration in China, its basis is the housing cadastre. However, there is no explicit definition of housing cadastre till now. Most researches have followed the former concept of 'Housing Property'. As one of the innovation points for the SULBRD proposes the concept of Housing Cadastre as:

- *Housing Cadastre refers to the register book which records the attribution of rights and the content of housing* (Bureau of Land Resources and Housing in Chongqing Municipality, 2010b), *which consists of two main parts: the room and its located building* (Yan, 2010).

Specifically, the room and building cadastre can be defined as:

- *Room: refers to the basic unit for housing registration.*
- *Building Cadastre: refers to the closed building unit with its ownership state, which is adjudicated and surveyed by housing department and survey department respectively* (Bureau of Land Resources and Housing in Chongqing Municipality, 2010b).

With years of research on housing management, the widely adopted data model for housing object is 'Mound – Building – Floor – Room' model (Y. Zeng, 2008). In this model, mound is a bounded plot on the surface. Building object is used to describe the building which is physically visible. Floor object is to depict the information of a certain floor. At last, the room object is the minimal unit for housing management. Based on the analysis of aforementioned data model and its related objects, the proposed housing object model can be shown as follows:

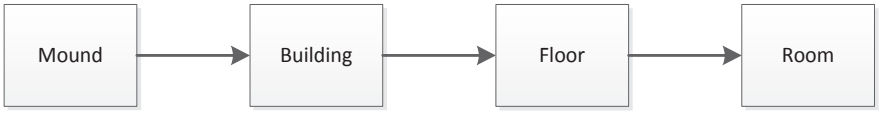

Figure 2-3 Housing Object Model

According to the provision of the REAL issued in 1994, it is necessary to introduce an integrated mechanism for land and housing registration in China. Especially with the issue of the PL in 2007, the objective of 'five integration' should be achieved, which includes organizational integration, effect integration, procedure integration, certificate integration and legal basis integration (Y. Wang, 2006). And all of these integrations should take the integration of databases as a prerequisite.

Meanwhile, the issue of multi-source data integration will be composed of two main aspects: on the one hand, it means the datasets match geographically, topologically, and have a correspondence of attributes(Usery et al., 2005), and combination of multi-source data through the establishment of relations between them (Tuladhar et al., 2005), on the other hand, it refers to the establishment of institutional, legal, social and policy framework. As illustrated in Figure 2-4, without investigating all technical and non-technical issues together within a single framework, effective spatial data integration cannot be achieved (Mohammadi, 2008). Therefore, this research will put emphasis on database integration as the first step for the integration of land and housing management in China.

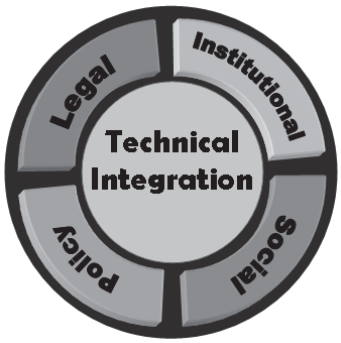

Figure 2-4 Technical and Surrounding Non-Technical Components of Data Integration (in Mohammadi (2008))

Consequently, the 'Subject – Right – Object' model will be changed according to the situation above. And its key feature is the object part, which will be become an integrated object including both land and housing objects. Figure 2-5 shows this integrated variant model under these integrated requirements in China.

Figure 2-5 Integrated Variant for Land and Housing Management in China

2.3. Overview of Land and Housing Management in China

With development of society in China, the management mechanism of land and housing is developing too. Moreover, the institution and policy about land and housing management is changing and adjusting with the development of society and economy. After the new China founded, it can be generally divided into four periods in general:

- **From the Early Days of the New Country to the Period of National Economy in 1956: Ruling over the Real Estate Stage**

In the early days of the new country, the central people's government published a series of laws and regulations, like "Decision for Unified Management of Public Housing and Property", "Agrarian Reform Law of the People's Republic of China", "Measures of Land Requisition for State Construction", etc. Based on these laws and regulations above, real estate, including land and housing, was unified managed by the Department of Real Estate.

- **From Socialist Transformation in 1956 to Reform and Opening-up: Prefer Housing to Land Stage**

In this stage, the management of land and housing was established according to laws. And in the urban areas of China, land was freely used for ever under the Administrative Transfer System. Due to the policy of freely unlimited use of land, that forms the phenomenon of "Prefer Housing to Land"(Shi, 1995).

- **From Reform and Opening-up to 90's: Separated Management of Land and Housing Stage**

Along with the unceasingly thorough development of the reform and open policy, land paid use system was introduced. In 1985, the Ministry of Land was founded, and then different levels of land departments came out too. That led to the situation of separated management of land and housing. Moreover, in 1987, Shenzhen City took the lead in updating the land tenure system, which is the transfer system of land use right and land ownership separation (S. Chen, 2001).

- **From 90's on: Integrated and Separated Management of Land and Housing Exist Simultaneously**

For urban housing registration in China, the owner has to register with two separate authorities in order to obtain two different entitlement certificates, namely, a certificate of housing ownership with a housing authority and a certificate for a land use right with the state land administration authority (Randolph & Lou, 2000). Up to now, only in some relatively developed regions of China, notably in Shanghai, the local housing authority and land authority have been merged to issue a single certificate combining land use right and housing ownership (L. Chen, 2012). Along with the issue of the REAL in 1994, and especially for the promulgation of the PL, this marked the start of the integration of land and housing issues all over the country. That is to say that there should be one department taking charge of both land and housing management in China. And Figure 2-6 proposes a common structure for integrated Real Estate Management (including land and housing management) in China.

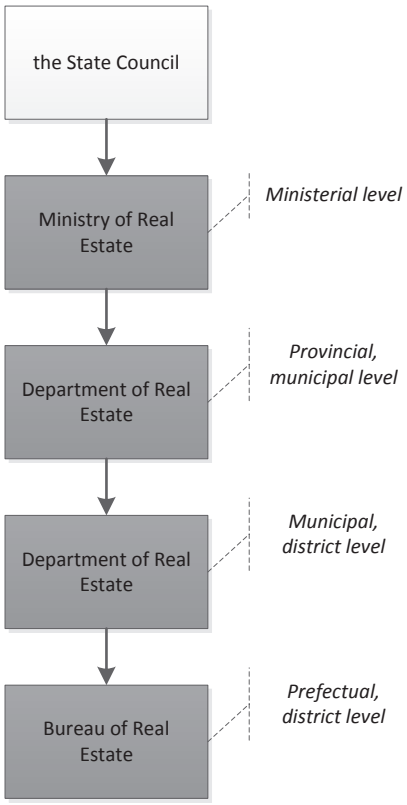

Figure 2-6 Integrated Mechanism for Real Estate Management (In (X. Wang & Zhou, 1998; Y. Wang, 2006))

2.4. Needs for the Integration of Land and Housing Databases in China

Housing is rooted on land, while land is the carrier for housing. Meanwhile, in the Chinese real estate market, land and housing will be tackled as a whole object too. Therefore, regardless of its natural attribute and economic attribute, land and housing should not be separated (Shi, 1995).

2.4.1. Drawbacks for the Current Separation of Land and Housing Management

Currently, most of the provinces in China carried out the separated administrative mechanism for land and housing. One of the important reasons is the separated setting of land and housing organizations (He, 1995). And such separation is not good for the unified management of land and housing in China from the long-term perspective. Specifically, such separation will result in several drawbacks(Y. Wang, 2006):

- Resulting in a number of housing certificates for illegal land, and land certificates for illegal housing;
- Bringing out the phenomenon of incomplete certificates for both land and housing;
- Leading to inconsistent transfer of land and housing rights; and
- Different survey accuracies for land and housing department will lead to the conflicts on these certificates.

2.4.2. Needs for the Integration of Land and Housing Management

The development of China's economy, especially with China's entry into the World Trade Organization (WTO), pushes the protection for property rights(L. Chen, 2012). In order to meet such demands, Property Law was introduced.

According to the provisions of related laws and regulations, such as REAL, PL and others, a uniformed registration of land and housing is really urgent in China for satisfying the development of real estate market and the protection of property rights. In conclusion, such integration is an inevitable trend so as to meet these general needs as follows, which is acquired from (Hongyu, 2004; Y. Wang, 2006):

- **Needs for the Management of Housing Property and Cadastre**: The indivisibility of land and housing leads to the interrelationship between cadastre and housing property, which would ultimately call for the integration of land and housing property.
- **Needs for the Promotion of Information-based Office**: Information technology in real estate management has been strengthening the construction of "one network, multi- offices", which would gradually make "simplify the procedure, shorten the time commitment" a reality.
- **Needs for the Government Decision-making and Society Development**: to provide accurately statistic data services for the government decision-making, urban planning, and land development.

With the booming development of real estate market in China, the traditional real estate management is becoming unsuitable for its activities. All of these result in a necessity of land and housing integration, and also lay a foundation for the future organizational reform in China (Y. Wang, 2006).

2.5. Review of Possibe Solutions for Land and Housing Integration

In order to overcome the integration problem of land and housing databases, much work are being done, including overseas and China specific.

2.5.1. Present Global Research Situation

Most of overseas countries and regions practice the mechanism of private land ownership (Z. Wang & Liu, 2002). Under such mechanism, besides land parcel, the housing and other attachments on the land will be treated as the property of government or individuals. Thus, on the management of land and housing, they practice the integrated management mechanism of land and housing, namely cadastral management.

However, there are still a number of countries which is not unified recorded. As for such situation, some of them record the housing information in separate parts of land registers, for example Latvia, Lithuania, Sweden, etc. In Greece, housing is recorded as a separate layer in the real property database. In Finland, such information is kept in a separate building and dwelling information register, namely the Population Register Centre. In Norway, this system is known as GAB – ground, address and buildings (UN-ECE, 2004). While in some other countries, integration is the key solution. In Slovenia, Pogorelčnik and Korošec (2001) introduced an electronic Land Register for the maintenance of title date at a single location and its use by three records (land cadastre, housing cadastre and land register), which is under the Real Estate Registration Modernization Project. And for Denmark, they created the Cross-Reference Register (KKR) to link three separate registers: building and dwelling register, valuation register and cadastral register (Stoter et al., 2004).

2.5.2. Present China's Research Situation

Currently, land and housing are managed by the MLR and MOHURD respectively. This separation may lead to the problem of inconsistency between land and housing data. To tackle such problem, the Chinese government and many scholars have already made some efforts.

From the theoretical perspective, there are a number of studies on this issue. Hongyu (2004) studied on the design and development of integrated management information system for land and housing, including the requirement analysis, system design and key technical problems of the system development, etc. H. Zeng and Zhuang (1997) elaborated the objective requirement and operation form of the unification of land and housing certificates. Moreover, Wu (2002) discussed about the requirements of the integration of land and housing in the field of cadastral survey. Furthermore, for the solution of integration between land and housing in China, Liu (2007) proposed an integrated data model by using Federated Data Model (FDM). While some others concentrated on the real property information by utilising the concept of cadastral domain model (Li et al., 2012; Zhang et al., 2008)

From the practical perspective, several laws, regulations and specifications have been published. Anhui, Guangdong, Beijing and Shanghai have pushed forward with the integration issues. To be specific, the "Regulations of Guangdong Province on Urban Real Estate Ownership Registration (Fixed)" was issued by the National People's Congress Standing Committee of Guangdong Province in 1994. Article 3 of this regulation provided that the real estate administrative department at or above the county level was in charge of real estate property management. And this department, which was under the entrustment of the people's government at the corresponding level, was to apply for the activities of registration and issuing certificates (The Provincial People's Congress Standing Committee of Guangdong Province, 2012). And along with the promulgation of the "Regulations of Shanghai Municipality on Registration of Real Estate" and "Regulations of Anhui Province on Real Estate Transaction Management" in 2002 and 2000 respectively, the institution for the integration of land and housing certificates was finally established. Moreover, in 2007, the Property Law was founded in order to push the process of real estate registration (The National People's Congress, 2007).

Subsequently, for the implementation part, the Chinese government decided to merge the land and housing bureaus around 1999. However, due to the bureaucratic reasons, most of these bureaus returned to their original status(Liu, 2007). Currently, only a few developed municipalities and provinces have merged into one bureau, such as Shanghai, Beijing, Anhui, Guangdong, etc. With the integration of land and housing certificates in about 90% of Anhui Province, the time spend on certification and the organization-personnel have been improved. And in Shanghai, the operation of certification is becoming more efficient and cheaper from then on (Y. Wang, 2006). In addition, the three modes, including "Integration of Organizations and Certificates", "Integration of Certificates, and Separation of Organizations", and "Separation of Organizations and Certificates", coexist in Guangdong province (The Standing Committee of Jiangsu Provincial People's Congress, 2005).

2.6. LADM

The International Organization for Standardization (ISO) standard of LADM is defined as a reference model for the LAS development covering basic information-related components of land administration (ISO/TC211, 2012). It was launched at the FIG Congress in Washington D.C. in 2002, which is introduced by C. H. J. Lemmen and Van Oosterom (2002). And it functions as standardization for supporting system development and data exchange, which is to achieve the goals of modelling LASs and as a basis for communication (Uitermark, 2010). Thus, the LADM was provided as a tool for solving the land and housing integration problem in the standards level.

2.6.1. Possibility of LADM Adopted for Integration Issues

Van Oosterom et al. (2009) introduced the concept of Land Administration levels of maturity and four stages were identified: Standards, Connectivity, Integration and Network (See Figure 1-1). According to this LAMM model, integration plays as the third phase for the development of land admonition. And standards hold the basic needs and the initial step for maturity of land administration. Moreover, for this model, no level can be omitted as the subsequent level builds on the previous one. Therefore, standardization can be a potential solution for the integration of land and housing databases in China.

Once standards are clear, different organizations or countries can start to make a connection and further integration. Moreover, standards are in support for data quality by avoiding inconsistencies. And C. H. J. Lemmen (2012) also claimed that the LADM can be utilised for the establishment of a shared ontology and to facilitate the cadastral data exchange with and from a distributed LAS.

2.6.2. Principle of LADM

The principles of LADM is mainly based on 'Cadastre 2014' (Kaufmann, 2001) and the pattern of 'People – Land' relationships. In general, it serves as a shared ontology, which allows enabling communication between involved persons within one country and between different countries. Moreover, it shall facilitate cadastral data exchange within distributed LASs and support for data quality management in land administration (C. H. J. Lemmen, 2012). That is to the avoidance of inconsistencies between organizations.

2.6.3. LADM Packages and Basic Classes

LADM is a conceptual schema, which is organized into three packages, and one sub-package. These three packages are: Party Package, Administrative Package, and Spatial Unit Package. The Surveying and Representation Sub-package is a sub-package of the Spatial Unit Package (ISO/TC211, 2012).

Each package is a group of classes, with a certain degree of cohesion. And packages are utilized to facilitate the maintenance of different data sets by different organizations. Thus, such model will be implemented by organizations to support data maintenance activities and the provision of information. And corresponding to these packages, four basic classes will be introduced then. And all these four classes form the common pattern of 'people-land' relationship, which is the core LADM (based on four basic classes) is introduced, as is shown below (ISO/TC211, 2012):

- **Class LA_Party**: this is the main class of the Party Package, and it has a specialization: LA_GroupParty (which means a group of parties).
- **Class LA_RRR**: this is one of main classes of the Administrative Package, and the instances of subclasses of LA_RRR are rights, restrictions or responsibilities.
- **Class LA_BAUnit**: this is the other basic class of the Administrative Package. And it is needed, among other things, to register "basic property units", which consists of several spatial units, belonging to a party, under the same right. According to UN-ECE (2004), the basic property unit specifies that the extent of land is one unit of ownership. That means RRR should be unique for each baunit in order to establish a unique combination between parties, RRRs and BAUnits.
- **Class LA_SpatialUnit**: this is the main class of the Spatial Unit Package. Spatial units can be grouped into two forms: spatial unit groups and sub spatial units. And they also can be refined into two specializations: building units and utility networks.

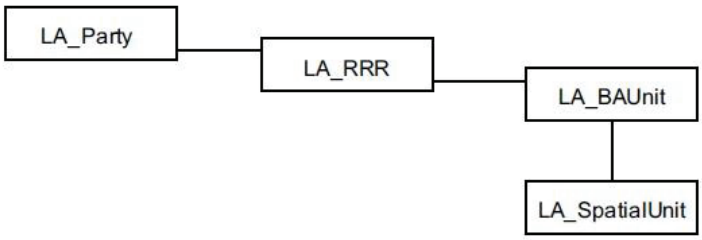

Figure 2-7 Basic Classes of the LADM (in ISO/TC211 (2012))

2.6.4. LADM in the Global Context

When LADM as an international standard is finalised, it will be used a basis for the development of LASs. Till now, there have been several country profiles and examples exist for customising LADM to meet specific needs.

Elia et al. (2012) proposed a LADM based Cyprus Land Information System model to support the upgrading of the Cyprus Land Information System (CLIS). Hespanha (2012) addressed a system development methodology to support the creation of an integrated land by applying LADM in Portugal. In Honduras, Jan Koers, Christiaan Lemmen, and Rodimiro Espinal designed a one-stop shop named Sistema de Información Gestion Integral de Tierras (SIGIT), which is based on LADM, to manage the cadastre in a multi-user and business process oriented way with international support and open source technology programmed. And this is a real implementation effort based on LADM and Model-driven Architecture (MDA) (C. H. J. Lemmen, 2012). The LADM use is also being conducted in relation to the Infrastructure for Spatial Information in the European Community (INSPIRE) Data Specification on Cadastral Parcels, showing that the INSPIRE development fits within the LADM and that there are no inconsistencies (C. H. J. Lemmen et al., 2009). Moreover, the Social Tenure Domain Model (STDM), as a "specialization" of LADM, is to support pro-poor land administration and meant specifically for

developing countries (Uitermark et al., 2010). Generally, the LADM should be expandable and it is likely that additional attributes, operators, associations, and perhaps new classes, will be needed for a specific region or country. Hence, the LADM country profile for China is needed too.

In conclusion, based on the discussion above, this research will utilise LADM as a standard model for the Land Administration Domain, with a focus on the stage of standardization to achieve the goal of database integration between land and housing databases in China.

2.7. Concluding Remarks

In conclusion, this chapter was carried out to establish the theoretical basis of the research, including the basic concepts, development history of land and housing management, the drawbacks and needs for the integration of land and housing databases in China, and the potential solution adopted in this research. To be specific, this chapter started from the concept of cadastre, land cadastre and housing. Based on these concepts, the integrated variant for land and housing management was introduced. As for the needs of this integration, it has turned out to be an inevitable trend, not only from the historical perspective, but also from the management perspective. With regard to this land and housing integration problem, much work has been done all over the world, especially in China. On the basis of this discussion, this thesis tries to introduce the LADM International Standard as a tool for solving this problem.

According to the research methodology, this chapter situates in the second phase – literature review. It provides the theoretical foundation of this research. Next, the detailed research methodology will be illustrated.

3. RESEARCH METHODOLOGY

3.1. Introduction

This chapter emphasizes on the methodology followed to conduct the research. Specifically, section 3.2 is to illustrate the general design of the thesis. And it is mainly divided into three stages: analysis, design and evaluation. Then the next section is about the description of research approach. The secondary data like related legislations is the main data source and its corresponding method, as is presented in section 3.4. Finally, these three key segments, as analysis, design and evaluation, will be described in detail in section 3.5.

3.2. Research Design

Generally, as is stated in previous chapters, the tasks of this research can be categorized into three steps according to objectives in chapter 1, as follows:

1) Analysis

- In this stage, there are two main tasks: one is to collect legal requirements for the integration of land and housing databases in China from related legislations, and
- the other is to analyse the existing structure for land and housing database on the basis of the SULBRD, which is the standard for land and housing database in Chongqing Municipality.

2) Design

- For the design stage, the key issues of this stage include the migration from chosen classes to the LADM classes, and then
- the development of the country profile China based on the principle of LADM.
- And the inputs used in this process are these legal requirements and existing structure collected from the analysis stage.

3) Evaluation

- In this phase, an evaluation will be performed to test the integrated data model in relation to legal requirements, and
- the evaluation framework will be composed of two parts: the verification of these legal requirements and the abstract test of the country profile China.

3.3. Research Approach

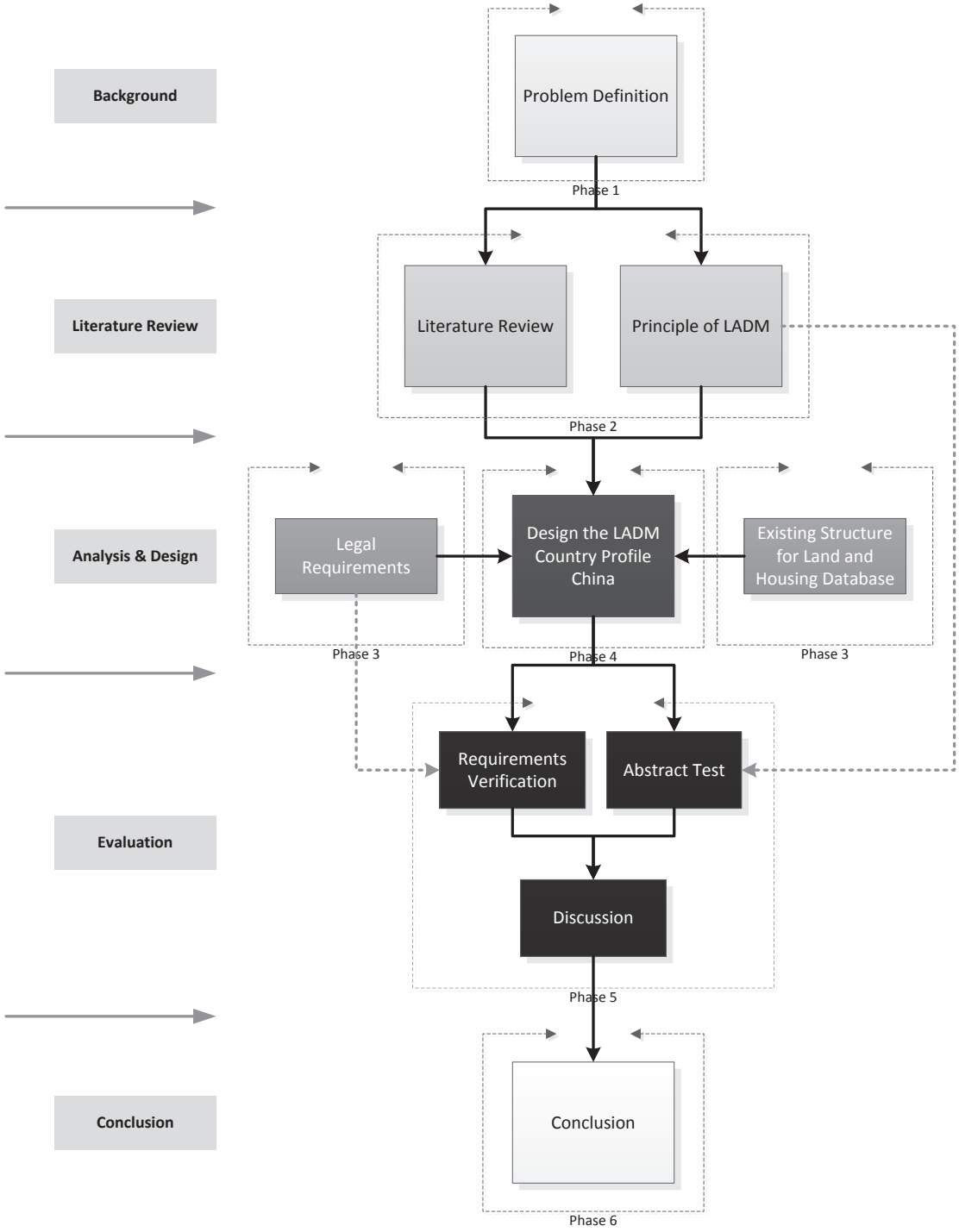

Figure 3-1 Research Approach

To the specific, Figure 3-1 shows the research approach for achieving the research objectives. The following sections present an explanation of the proposed approach.

Phase 1 Problem Definition

In this phase, the research problem, objectives and subsequent questions are posed to achieve the objectives, and the general strategy was designed too.

Phase 2 Literature Review

In this stage, the background knowledge of data integration, the development of land and housing management in China, and the basic principle of LADM are reviewed through documents and literatures. The aim of this stage is to explain the foundation theories related to the research problem.

Phase 3 Analyses of Legal Requirements and the Existing Situation

As for this stage, there are two main tasks: collection of legal requirements and analysis of the existing situation. For collection of requirements, first is to give a general explanation of the land legal system in China. Secondly, according to such system, a number of related legislations and subsequent legal requirements will be collected. Next, the existing structure for land and housing database will be studied with a focus on the SULBRD of Chongqing municipality.

Phase 4 Development of the LADM Country Profile China

For this design stage, the first task is to make a comparison between chosen classes and the LADM classes. Then according to these comparison results, the LADM country profile China will be developed. The aim of this step is to develop a LADM-based integrated data model in Enterprise Architect (EA) by considering the current and required structure for land and housing database in China.

Phase 5 Evaluation of the Country Profile China

In this step, the main work is to develop an evaluation framework by carrying out two main missions, which are the verification of legal requirements and the abstract test for the country profile China. And these two missions will be developed based on the collected requirements in Phase 3 and the abstract test suite in Annex A of the LADM standard. The aim is to evaluate the achievement of legal requirements and the compliancy of the country profile China.

Phase 6 Conclusion

This research puts emphasis on three main parts: analyse the legal requirements for the integration of land and housing databases, develop an integrated data model and evaluate such model through requirements verification and abstract test. By going through these three phases, the legal requirements for land and housing integration will be verified and the LADM country profile China will be developed and tested too. In addition, the answers to the research questions are revisited and several recommendations will be proposed in this stage.

3.4. Data Sources and Corresponding Methods

This research would mainly start from the secondary data sources, which serve as the basis for the collection of user requirements and the analysis of the current structure for land and housing database in China. Firstly, for the collection of user requirements, due to the limitation of time for the thesis, the main focus will be related land and housing legislations. Then for the analysis of the current structure, the picked pilot would be the Chongqing municipality, which has already integrated land and housing databases. And the adopted source will be the SULBRD of Chongqing municipality. In addition, the principle of LADM plays as the support for the design of the country profile China, and the results generated from the previous stages are another input for the research.

According to the research design matrix of Table 1-1, literature review will run through the whole process of this research. That is to say desk research will be the main method adopted in this research. Specifically, such method includes the review and collection of related documents, and the study of the LADM standard. Moreover, for each stage of the research, there will be a number of specific methods applied. As is also shown in Table 1-1, these specific methods consist of the synthesis method for the analysis stage, the design method for the design stage and the evaluation method for the evaluation stage.

3.5. The Core Process of Research

Generally, as is stated above, the core of the research consists of the analysis, design and evaluation stages, which respectively correspond to Phase 3, 4 and 5 in the research approach (See Figure 3-1). Firstly, at the stage of analysis (Phase 3), the current situation of land and housing databases in China will be figured out, as well as the legal requirements for the integration of land and housing. Then, based on the results of analysis phase, an integrated data model will be designed through the LADM standard. Lastly, the

evaluation framework will be developed to verify the achievement of legal requirements and to test the compliancy of the country profile. Specific details are posed as below.

3.5.1. Analysis of the Current Situation and Social Needs

At this stage, two main issues will be done. One is the analysis of current data structure for land and housing in China. And the other is about the collection of legal requirements for the integration of land and housing databases.

- **Legal needs for the integration of land and housing**

By considering the limited time of the research, the source adopted for this part will be related laws and regulations. Then based on these collected legislations, a number of legal requirements for the integration of land and housing will be synthesized then.

- **Current situations of land and housing databases**

As is discussed in section 3.4, the foundation for this part will take Chongqing Municipality as a case study. Thus, the SULBRD of the Chongqing Municipality will be the key data source for this section. Based on this publication, the existing situation for the integrated land and housing database will be figured out.

3.5.2. Design of LADM-based Data Model

Prior to the design part, the first mission of this stage is to migrate from the chose classes to the LADM classes. And then based on this output, the LADM country profile China will be developed. As for this procedure, the prerequisite data sources include the standard of SULBRD and the required classes and code lists from legal requirements.

3.5.3. Evaluation of the Integrated Data Model

Following the design phase, the evaluation framework will be developed then. Specifically, as is shown in Figure 3-2, the verification suite will be produced based on the collected legal requirements in the analysis stage. Subsequently, an abstract test will be performed in the meantime. Through such test, the compliancy of the country profile China will be examined too. Lastly, based on the results generated from the evaluation process, a discussion section will be arranged then. The main objective in this stage is to verify the achievement of the requirements and to test the compliancy of LADM-based model.

3.6. Concluding Remarks

This chapter gave a concrete description of this research methodology. First of all, this research will go through 6 phases. And its core is from phase 3 to phase 5, which are analysis, design and evaluation. Specifically, the analysis stage will complete two main tasks: analysis of legal requirements and current structure for land and housing database. Then the design stage will be carried out by referring to the LADM standard. Finally, the LADM country profile for China will be evaluated through requirements verification and the LADM abstract test suite. Secondly, as for the data sources adopted in this research, the main focus is related laws and regulations. Thus, the general research method is desk research accordingly.

According to the research methodology, next chapter will start from the first part of analysis stage, which will utilize related legislations.

4. ANALYSIS OF LEGAL NEEDS FOR THE INTEGRATION OF LAND AND HOUSING DATABASES IN CHINA

4.1. Introduction

As is stated in chapter 3, for solving the integration problem in China, there will be 3 main steps need to go through, which are analysis, design and evaluation.

First of all, in the analysis stage, the key issues are to analyse the general needs for the integration of land and housing databases in China, and to figure out the existing structure for the land and housing database, which will take the Chongqing Municipality as a study case. This chapter will mainly focus on the former part, these are, general needs for the integration problem. And the latter will be studied in the next chapter. Specifically, these user requirements will be collected based on related legislations. Section 4.2 describes the current land legal system in China. And then based on such system, legal requirements for the integration will be reviewed in Section 4.3. Finally, these requirements will be synthesized in Section 4.4.

4.2. Current Land Legal System in China

Land legal system is a laws and regulations organized system, which is aim at regulating the relationship coming from land use, development, protection, and land market. So far, the land legal system in China has been established for the backbone of Land Administration Law and Urban Real Estate Administration Law (Cai & Ke, 2001). From the perspective of legislative system, Chinese current land legal system mainly consists of 7 levels:

- **Constitution**: it is the basis of land legal system. It provides the state-owned land ownership in urban areas and collective-owned ownership in rural and suburban areas (The National People's Congress, 2004).
- **Land Laws**: it refers to laws which are enacted by the National People's Congress (NPC) and its Standing Committees. Such as the Land Administration Law, Property Law, Urban Real Estate Administration Law, etc.
- **Land Statutes**: such kinds of statutes are enacted by the State Council. The land statutes act as an important part of the legal system, like the Regulations on the Implementation of the Land Administration Law.
- **Local Land Statutes**: these statutes are enacted by the Local People's Congresses (LPC) and their Standing Committees at the provincial and municipal level.
- **Land Regulations**: these regulations are enacted by the ministries and commissions under the State Council. And the regulations at this level play an important role in the legal system, such as the Measures for Land Registration, Building Registration, and Real Estate Registration.
- **Local Land Regulations**: these kinds of local land regulations are enacted by the local governments of each province and municipality, autonomous region.
- **Other Land Standards**: the standards at this level refer to the documents which are outside the scope of the 6 levels above.

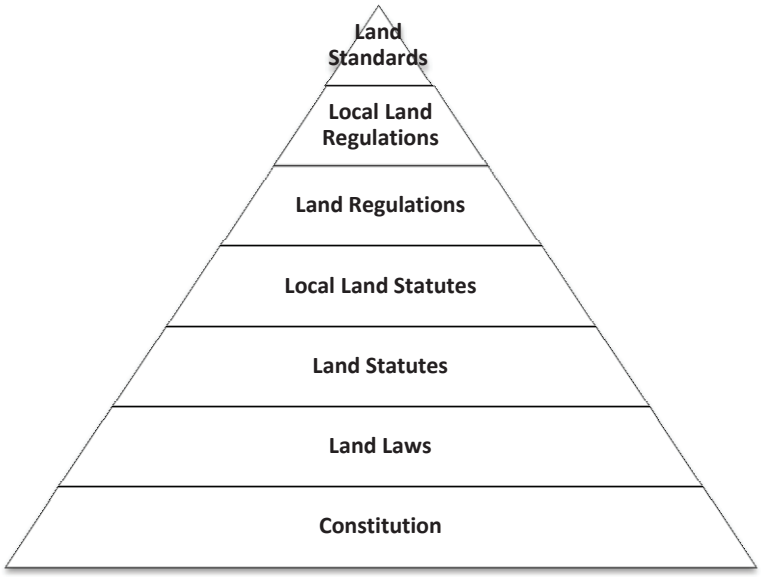

Figure 4-1 Current Land Legal System in China (Adapted from Cai and Ke (2001))

Figure 4-1 presents the hierarchical model of land legal system in China. As is shown in this figure, the force of laws above decreased in steps from constitution to land standards. Specifically, Constitution is the basis of the whole legal system. The force of land laws ranks only second to the Constitution. And each previous level of legislations acts as the foundation of the next level (Cai & Ke, 2001).

4.3. Legal Requirements

As is presented in previous chapters, for historical reasons, currently, land and housing data are separately managed by MLR and MOHURD in China. That causes a series of problems like duplication of data storage, inconsistent updating, tenure insecurity, etc. Based on such situation, the user requirements for data integration can be extracted from several aspects. And, this research will mainly focus on related legislations, which will be specifically described in the following subsection.

4.3.1. Review of Related Laws and Regulations

According to the land legal system, the general framework of land legislations has been established. By considering the integration between land and housing databases, a number of legal requirements will be collected then, which can be generally categorized into three main parts: only land related, only housing related and real estate related laws and regulations.

Table 4-1 Overview of Related Laws and Regulations

Categories	Laws and Regulations	Related Articles	Detailed Transcriptions
Only Land Related	Land Administration Law of the People's Republic of China & Newest Land Administration Law of the People's Republic of China	Article 12, 46, 47, 55, 57, 83 (Living) Article 19, 28, 29, 31, 93, 96, 97, 99 (Revising)	For detailed transcriptions of these articles, we can refer to Annex 1.
	Measures for Land Registration	Articles 9, 15, 40, 75	
	Regulation on the Implementation of the Land Administration Law of the People's Republic of China	Article 6	
Only Housing Related	Measures for Building Registration	Articles 8, 30, 60, 95	
Real Estate Related	Property Law of the People's Republic of China	Articles 10, 12, 22, 135, 136, 138, 146, 147, 148,	

	Law of the People's Republic of China on Urban Real Estate Administration	Articles 32, 34, 45, 48, 49, 61, 63	
	Technical Specification of Real Estate Registration	Articles 1.0.3, 5.5.7, 6.1.3, 6.1.4	
	Guaranty Law of the People's Republic of China	Article 34, 36, 42, 55	

Land Administration Law of the People's Republic of China (The Standing Committee of the National People's Congress, 2004) & Newest Land Administration Law of the People's Republic of China (The Standing Committee of the National People's Congress, 2012)

- **Description:** In order to strengthen the administration of land, protect land resources development, rational utilization of land, and earnestly protect cultivated land, and promote the sustainable development of society and economy. The Land Administration Law of China was approved at the NPC on June 25th, 1986, and then it was revised respectively in 1998 and 2004. The current using one is the 2004 version. Based on such law, the change of land tenure and content shall go through the maintenance of registration (Article 12). According to article 46 and 47, in expropriating land, compensation shall be made based on the original use purpose of land. In addition, the land use leasing fees need to be paid for the use of construction land. And the temporary land should be pay attention too (Article 57).

  With the development of society, all kinds of new requirements for land administration are ever growing, which propose a new revision for the Land Administration Law. In 2009, the MLR submitted a revision draft to the State Council for examinantion. In this draft, the separately established land use right and unified land registration system were proposed and written in articles.

- **Related Classes & Attributes:** according to the discussion above, there are several attributes which can be extracted. First of all, in the current Land Administration Law, the change of land tenure and use purpose during maintenance, the time limit for compensation registration, the compensation fees for land expropriated, land use right leasing fees for obtaining the State-owned land and the restriction for temporary use of land should be included. Then, based on the revision draft, the scope of land use right has been extended to vertical level. And the unified land registration system was written in articles. In addition, the mode of paid use of construction land and its term, and the land price was formulated too.

Regulations on the Implementation of the Land Administration Law of the People's Republic of China (The State Council, 1998)

- **Description:** Based on the Land Administration Law, the Regulations on the Implementation of the Land Administration Law of the People's Republic of China was promulgated on December 27, 1998, and was effective as of January 1, 1999. According to article 6 of the regulation, whoever changes in land ownership and use right according to laws as a result of transfer of its appendices must file an application for change in land registration with the corresponding department which is locally wherein the land is located, the original land registration organ shall effect the change in registration of land ownership and use right (The State Council, 1998). That means the changes of appendices also will result in the change of corresponding land rights. Moreover, the change of land use purposes should file the application of maintenance too.

- **Related Classes & Attributes:** according to the highlights in the related articles, the needed attributes can be summarized into the changing information about land and its appendices, such as application form, identification materials, certificates of rights of land and its appendices, and other relevant documents referring to the alternation of land and its appendices.

Measures for Land Registration (Ministry of Land and Resources, 2007a)

- **Description:** The Measures for Land Registration is a kind of land regulation, which was deliberated and adopted at the fifth executive meeting of the MLR in 2007, and had come into force since 2008. As is mentioned in this measure, the submitted materials for the application of land registration should contain the documents of both land and its appendices, see Article 9 and 40. And in the

register book, the information of both land and its appendices will be recorded too, see Article 15. According to Article 40, the maintenance of land registration requires certificates of land use right, housing ownership and other documents. In addition, in the supplementary articles, the unified registration system of real estate is proposed.

- **Related Classes & Attributes:** based on the underlined texts above, the attributes for land registration would include certificates of land and appendices, application form, identification materials, survey documents and taxation documents when filing an application for land registration. Specifically, the information about the subject, rights, and object will be written in the register book. Moreover, the maintenance of land use right requires the certificates of both land and housing rights, and documents about alternation of land use right.

Measures for Building Registration (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008)

- **Description:** According to the Property Law and Real estate Law, the Measures for Building Registration were hereby issued and became effective in 2008, to regulate the conduct of housing registration and to maintain the real estate transactions. The key features in this measure contain: subject consistency of land use right and housing ownership (Article 8); submitted materials for registration includes documents about both land and housing rights (Article 30, 60, etc.). Moreover, the unified registration of real estate by one department is also mentioned here (Article 95).
- **Related Classes & Attributes:** In registering housing ownership, subjects for land use right and housing ownership is needed for the principle of subject consistency. In addition, when applying for the registration of housing ownership, it is necessary to include application form, identification materials, certificate of land use right, construction planning permit, document of as-built inspection of building and report of housing surveying and mapping. In addition, the mortgage registration requires the contract of mortgage too.

Property Law of the People's Republic of China (The National People's Congress, 2007)

With the development of Chinese market economy, the government now acknowledges their desire for legal protection of private property. In order to answer these demands, Property Law was introduced in 2007 (L. Chen, 2012). According to the Property Law, the key feature is the integrated mechanism of immovable property registration in China.

- **Description:** The Property Law of the People's Republic of China is the legislation about property, which was adopted by the NPC in 2007 that went into effect on October 1, 2007. As a key issue in the property law, registration has attracted more attentions. Article 10 and 246 of this law provides that registration of a realty shall be handled by the registration organ in a uniform way (The National People's Congress, 2007). Specifically, the right to use construction land shall be entitled to its appendices by making use of such land. And the land use right can be separately created on the surface of or above or under the land too (Article 135 & 136).

  Moreover, as is shown in article 182, *for mortgaging building, the right to use construction land within the area of this building shall be mortgaged together. When mortgaging the right to use construction land, all the buildings on such land shall be mortgaged together* (The National People's Congress, 2007). That is to say that land and housing also will be taken as a whole during the procedure of mortgage.

  For the maintenance of registration, the right to use construction land and its appendices shall be taken as a whole too (The National People's Congress, 2007). Article 146 and 147 of the property law states that whoever changes the right to use construction land or its appendices, the land and its affiliated facilities shall be taken as a whole, namely realty. According to Article 138, the information of both land and housing should be contained in the contract on transfer of the right to use construction land, in case the right to use construction land is created through auction, bid invitation or agreement (The National People's Congress, 2007).

  Furthermore, the registration organ is responsible for the examination of the ownership certificate and other necessary materials both about land and its attachments. According to Article 22, the realty registration fees shall be charged on pieces. That means the applicant would pay less for the registration of land and its appendices under this article. In addition, if the government wants to take

back the construction land before expiration, compensations shall be given to the houses and other realties.

- **Related Classes & Attributes:** According to the description above, the following attributes would be needed: first, for the registration aspect, the subjects of land and its appendices rights; the land use right on or above or under the surface of land. Then, for the mortgage aspects, the certificates of both land use right and housing ownership are needed. Thirdly, for the maintenance of registration, the land use right and housing ownership will be taken as a whole during the process, and the information about both land and housing will be included, such as the name and address, boundary and area, covered space, use purpose, use term, payment methods and dispute settlement method. In addition, the mode of transfer shall be recorded too. Moreover, for other aspects, the certificates and materials of land and housing are need for the examination of registration organ. And the registration fee of realty will be charged according to pieces of real estate. The compensation for real estate will be on the basis of both land and housing prices.

Law of the People's Republic of China on Urban Real Estate Administration (The Standing Committee of the National People's Congress, 2007)

- **Description:** The Law of the People's Republic of China on Urban Real Estate Administration was adopted by the 8th meeting of the Standing Committee of the 8th National People's Congress on July 5, 1994 and amended according to the "Decision on Amending the Law of the People's Republic of China on Urban Real Estate Administration" on August 30th, 2007. And the related articles about the requirements acquired from this law are shown as below (The Standing Committee of the National People's Congress, 2007):

  First of all, as is seen from Article 32, the housing ownership and its appurtenant land use right should be transferred or mortgaged together. And Article 34 states that the evaluation price of real estate should on the basis of both land and housing price.

  Secondly, the advanced sale of commodity houses must obtain the land use certificates and other relevant materials in advance. And it should be recorded in both land and housing departments too (Article 45). Moreover, Article 48 forces that "*The title of a housing property plus the right to use the land occupied by the housing property obtained lawfully may be designated as mortgage right. The right to use land obtained through lease may be used as a mortgage.*" The registration and certification system for the right to use land and title to the housing property is written by articles in this law.

  Thirdly, Article 61 presents that the transfer or change of a real estate should file an application with both housing administration and land administration department of the people's government above the county level. That means the transfer and change of real estate concerns both land and housing departments for the alternative registration.

  And lastly, this law also sets the unified registration and certification form, in order to tackle the situation of separated recoding of the housing title and the use right of the land on which the building is located in the real estate certificate.

  All these articles above may lead to the same objective, that is, integration of land and housing databases in China.

- **Related Classes & Attributes:** Apart from these required attributes mentioned above, for the real estate price evaluation needs to take both land and housing prices into consideration. And for the conditions of advanced sale of commodity housing, the certificates of both land use right and housing ownership and other relevant materials are needed. Moreover, for the transfer or change of a real estate, the application should be filed with both the housing and land administration departments of the people's government above the county level.

Technical Specification of Real Estate Registration (Ministry of Housing and Urban-Rural Development, 2012)

- **Description:** This specification was worked out based on the announcement from the MHOURD in 2012, and put into effect on June 1st, 2012. The aim of this specification is to specify the business issues of real estate registration and to safeguard the real estate transaction. Specifically, the real estate registration should follow the principle of subject consistency, that is, the subject of land use right and housing ownership should be same according to laws. Besides, the institution for real estate

registration should be merged and the archives of real estate registration should be managed in a unified way. In addition, it should be easy to access to these archives of real estate registration including both land and housing part through query tool.

- **Related Classes & Attributes:** Following on the discussions above, the archives of real estate registration should be uniformly managed, and the mutual query should be realized. And the responsible institutions for real estate registration and the management of archives should be included. In addition, the name of registrar and the date for verification need to be recorded too.

Guaranty Law of the People's Republic of China (The Standing Committee of the National People's Congress, 1995)

- **Description:** In order to promote the circulation of capital and commodity, and also to realize the protection of property right for movable and immovable objects, the Guaranty Law of the People's Republic of China was adopted at the 14th Session the Standing Committee of the 8th NPC on June 30, 1995, and came into effect as of October 1, 1995. This mortgage part of law mainly tackles two kinds of objects: movable and immovable. According to Article 34, the immoveable properties includes land use right, housing and other appendices. And in the Article 36, this legislation stipulates that for real estate mortgage, the land use right and the right of its related appendices shall be mortgaged at the same time. Moreover, there are several different departments handling the gage registration, such situation also leads to the motivation for the integration of land and housing issues. In addition, Article 55 states the situation for newly-built housing while preceding the mortgage.
- **Related Classes & Attributes:** based on these above, the required attributes can be presented as follows: the land use right and the right of its related appendices during the mortgage procedure; the responsible departments for land and other appendices respectively; and the built date for each housing within the mortgage contract and also the mortgage date.

4.4. Synthesis of Legal Requirements

Based on the analysis of related legislations above, these legal requirements can be synthesized into following categories, as is shown in Table 4-1. Specifically, as for the main objective of land and housing integration, those related legal requirements cover a number of categories in general, including registration, maintenance, mortgage, transfer of real estate rights, relevant materials and archives, preliminary notice, etc. These legal requirements cover several aspects of impacts. Then, series of classes and attributes can be extracted under each requirement.

Table 4-2 Legal Requirements for Integration of Land and Housing Databases in China

No.	Requirements	Impacts	Required Classes & Attributes	Sources
01	Initial Registration	For the initial registration of land, the related information about its accessories should be included in the register, and vice versa.	Land use right and its appurtenant housing ownership	• Article 28 & 29 (The Standing Committee of the National People's Congress, 2012) • Article 9 & 15 (Ministry of Land and Resources, 2007a) • Article 30 (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008)
			Registration date	
			Located county	
			Land Legal documents (Application form, identification materials of the applicant, certificates of land use right and housing ownership, alternation of land tenure)	
			Survey documents (cadastral & housing survey, parcel map, boundary coordinates)	
			Tax paid proof and tax reliefs proof	
			Name and address of land subject	
			Nature, type, acquired date, term of land tenure	
			Changes in land tenure and content	
			Location, boundary, area, identification, use purpose, acquired price of land	
			Housing legal documents (application form, identification materials of the applicant, Construction planning permit, document of as-built inspection of building)	

02	Maintenance	For the maintenance of real estate rights caused by transfer or mortgage, the land use right and housing ownership will be changed all together.	Changes in land tenure (includes land ownership or use right)	• Article 12 (The Standing Committee of the National People's Congress, 2004) • Article 6 (The State Council, 1998) • Article 40 (Ministry of Land and Resources, 2007a) • Article 61 (The Standing Committee of the National People's Congress, 2007)
			Changes in use purposes	
			Changes in housing ownership	
			Responsible departments (original land registration organ, housing administration department, land administration department)	
			Legal documents about alternation (Application form, approval documents,)	
			Certificates of land use right and housing ownership (original & new)	
03	Mortgage	For the mortgage of land or housing, it will be tackled altogether too, just as the alternative registration.	Legal documents (Application form (housing mortgage registration), identification materials of the applicant, mortgage contract, Master obligatory right contract, Certificate of land use right and housing ownership, Construction planning permit)	• Article 60 (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008) • Article 182, 183, 200 (The National People's Congress, 2007) • Article 32, 48, 49 (The Standing Committee of the National People's Congress, 2007) • Article 34, 36, 42, 55 (The Standing Committee of the National People's Congress, 1995)
			Built date	
			Mortgage date, loan, gage, priority	
			Name of mortgagor and mortgagee	
			Responsible departments (land administration department, housing administration department)	
04	Subject Consistency	According to the law, the real estate registration should follow the principle	Subject of land use right	• Article 8 (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008)

		of subject consistency.	Subject of housing ownership	• Article 1.0.3 (Ministry of Housing and Urban-Rural Development, 2012)
05	Unified Registration (including institutional and business)	In most of these related legislations, the unified registration has been written in articles. That is the real estate registration issue should be managed by one unified department, and one uniform certificate will be issued then.	Submission date	• Article 31 (The Standing Committee of the National People's Congress, 2012) • Article 75 (Ministry of Land and Resources, 2007a) • Article 95 (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008) • Article 10, 246 (The National People's Congress, 2007) • Article 63 (The Standing Committee of the National People's Congress, 2007) • Article 1.0.3, 4.5.5, 5.1.3, 5.1.5 (Ministry of Housing and Urban-Rural Development, 2012)
			Responsible department	
			Real estate registration identification	
			Located administrative division	
			Certificate of real estate	
			Verification and changes in the housing ownership and land use right	
			Name of Registrar	
			Record identification on the register book	
06	Registration Fee	The fee of real estate registration will be charged according to pieces.	Piece number of real estate object	• Article 22 (The National People's Congress, 2007)
07	Material Verification	As the responsible department for registration, it is necessary to check the certificates of land use right and housing ownership, and other related materials.	Legal documents (Certificates of land use right and housing ownership, other materials provided by the applicant)	• Article 12 (The National People's Congress, 2007) • Article 1.0.3 (Ministry of Housing and Urban-Rural Development, 2012)
			Name of registrar	
08	Land Use and Land Use Right	As is written in the property law, the scope of land use right can be extend to from the above space to the underground space.	Right type (e.g. temporary land use right)	• Article 57 (The Standing Committee of the National People's Congress, 2004) • Article 19, 93 (The Standing Committee of the National People's Congress, 2012) • Article 135, 136 (The National People's
			Term of land use right (e.g. temporary land use right: ≤ 2 years, commencement date and expiry date)	

			Payment to use of construction land	Congress, 2007)
			Space right to land use (surface, above, or under the land)	
			Subject of land use right	
			Restriction to land use right	
09	Transfer of Real Estate Rights (including Land Use Right and Housing Ownership)	For the transfer of land use right or housing ownership, the information about its attachments will be included in the register.	Land use right leasing fee	• Article 55 (The Standing Committee of the National People's Congress, 2004) • Article 97 (The Standing Committee of the National People's Congress, 2012) • Article 138, 146, 147 (The National People's Congress, 2007) • Article 32 (The Standing Committee of the National People's Congress, 2007)
			Other fees and expresses	
			Term of rights to use construction land (commencement date, expiry date)	
			Disposal method	
			Name, address of land subject	
			Boundary, area of the land	
			Covered space of appendices	
			Use purpose	
			Allotment fees and other fees	
			Disposal date of land use right	
			Disposal date of housing ownership	
10	Compensation of Land Acquisition	The compensation of land acquisition will be determined by considering the prices of land, housing and other	Subject of expropriated land	• Article 46, 47 (The Standing Committee of the National People's Congress, 2004) • Article 148 (The National People's
			Time limit for the announcement	

		accessories.	Compensation registration time for expropriated land	Congress, 2007)
			Responsible department	
			Certificate of land use right	
			Use purpose (original & changed)	
			Compensation fee (land, and appendices)	
			Term of expropriated land use right	
			Expropriated date	
			Land transfer fee	
			Purpose of public interest	
11	Real Estate Price Evaluation	According to the regulation, the real estate price will be determined by the standard land price, nominal land price, and appraised price of housing.	Standard land price	• Article 99 (The Standing Committee of the National People's Congress, 2012) • Article 34 (The Standing Committee of the National People's Congress, 2007)
			Nominal land price	
			Replacement price	
12	Advanced Sale of Commodity Housing, and Preliminary Notice	The advanced sale of commodity housing should follow several conditions, like the related certificates, and the permit of responsible departments.	Land use right leasing fee	• Article 45 (The Standing Committee of the National People's Congress, 2007)
			Certificate of land use right	
			Construction project planning permit	
			Funds put for construction, total budgetary investment (and per cent)	
			Construction schedule	

			Date of completion of the project	
			Permit of advanced sale of commodity houses	
			Legal documents for preliminary notice (application form, identification materials of the applicant, permit of advanced sale)	
			Advanced seller, advanced buyer	
			Department, term of preliminary notice	
13	Registration Archive (including Management and Query)	In order to support the real estate market and tenure security, the registration archives of real estate will be managed by one department, and will realize the quick query within or between databases.	Submission date	• Article 31 (The Standing Committee of the National People's Congress, 2012) • Article 15 (Ministry of Land and Resources, 2007a) • Article 1.0.3, 5.1.3, 5.1.5 (Ministry of Housing and Urban-Rural Development, 2012)
			Name and address of land subject	
			Nature, type, acquired date, term of land tenure	
			Changes in land tenure and content	
			Location, boundary, area, identification, use purpose, acquired price of land	
			Responsible department of register management	
			Identification for query	

4.5. Concluding Remarks

This chapter was the start of the core of this research. The analysis stage can be divided into two parts in general. And the focus of this chapter is the analysis of user requirements on the basis of related legislations. First of all, the current land legal system was introduced. Then based on this system, related laws and regulations were collected, as well as corresponding provisions subsequently. Next, these collected legal requirements were synthesized. Thus, a series of legal requirements were figured out, as well as required classes, attributes, etc.

With regard to the next chapter, the main focus would be another part of analysis stage, which is the analysis of existing structure for land and housing database in China.

5. ANALYSIS OF THE EXISTING STRUCURE FOR LAND AND HOUSING DATABASE IN CHINA

5.1. Introduction

In the previous chapter, the requirements for the integration of land and housing databases have already been studied and synthesized. As is mentioned in section 4.1, another mission in the analysis stage is to figure out the existing structure for land and housing database in China, which will be the main focus of this chapter.

This chapter will start from the existing provincial standard for integrated land and housing database in Chongqing Municipality, which is the pioneer for the integration of land and housing databases. Section 5.2 is an introduction section, which gives an introduction about the core structure of the SULBRD. Then, from section 5.3 to section 5.4 is about the specific study of the existing standard, which includes its proposed identification system and its content. Finally, in section 5.5, the proposed structure for the integrated land and housing database will be developed.

5.2. Land and Housing Cadastral Management in Chongqing Municipality

Nowadays, land and housing are still separately managed by two different departments in most of the areas in China. Up to now, only some relatively developed regions, like Shanghai, Chongqing, have already put these two types of issues into one department in the provincial level, namely Bureau of Land Resources and Housing (BLRH). And in order to realize the valid link between land and housing databases, and to unify the technical specification, the BLRH in Chongqing has launched the formulation of the SULBRD since 2010.

5.2.1. Historical Development of Land and Housing Cadastral Management in Chongqing Municipality

As is written in the Property Law, Land Administration Law and Urban Real Estate Administration Law, the integration of land and housing is an important issue recently. Yongchuan City under Chongqing Municipality is one of the earliest pilots on the institutional reform of land and housing integration. The land and housing departments of Yongchuan City were integrated in 1993. And until 1998, these two organizations merged into one all over the Chongqing Municipality, namely BLRH. Although two organizations have been merged, the certificates are still separately issued. Then in 2004, according the draft of Property Law, the Measures for Land and Building Registration in Chongqing Municipality was published to solve this drawback (Chunmiao, 2003).

Moreover, to achieve the goal of the integration of municipal land and housing registration and related data, and to solve the problem of the collaboration during the procedure of land and housing registration, the construction of integrated land and housing database started in 2007. Then in view of the present problems of these databases, and the current requirements for land and housing cadastre, the construction of corresponding management information system was launched in 2010 (Bureau of Land Resources and Housing in Chongqing Municipality, 2010a). Previous to this mission, it is necessary to formulate the Standards for Urban Land and Building Register Database in Chongqing Municipality in advance. Therefore, in 2010, the formulation of the SULBRD was launched by the BLRH and its trial version came into effect on February, 2010.

5.2.2. Core Structure of the SULBRD in Chongqing Municipality

During the process of formulation, this standard took a number of relevant standards and regulations as references (See Annex 2). Generally, the cadastral part of this standard is more or less the same as the Standard for Urban Cadastral Database (SUCD), which is the standard for the construction of urban cadastral database in China. Meanwhile, according to Yan (2010), one of innovative points of this standard is to bring land cadastre and housing cadastre into one standard for the first time. As for this standard, the main content is composed of four parts, which are the descriptions of basic elements, land, housing and property, and its structure can be illustrated as Figure 5-1.

As is provided in Ministry of Construction (formly Ministry of Housing and Urban-Rural Development) (2000), the management of housing property is composed of 'Housing Sheet Map – Housing Mound Map – Housing Room Map', which can be further interpreted as three levels: the first level is administrative area (Housing Sheet Map), second one is land (Housing Mound Map) and the third is room (Housing Room Map). For this separated situation of land and housing part, the conversional practice is to add a building level between the second and third level (Yan, 2010). While, with regard to the SULBRD, its corresponding practice is to introduce the statement of housing cadastre, which is composed of the room record and its located building record. In that case, the link between land and housing will be realized then (See the dotted line in Figure 5-1).

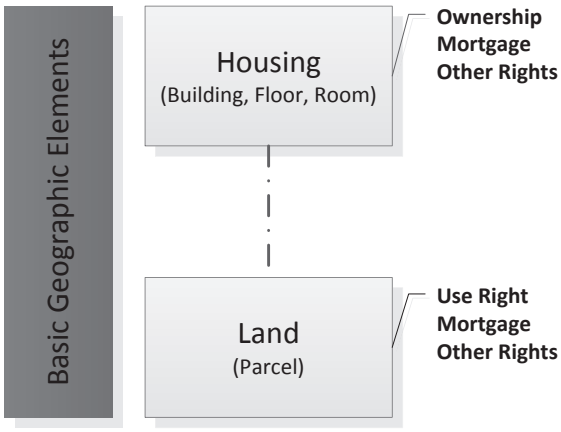

Figure 5-1 Structure of the SULBRD

5.3. Development of Identification System for Land and Housing Cadastral Database

Currently, due to the separate management of land and housing cadastre, the formulation of standards for land and housing cadastre are also launched by the MLR and MOHURD respectively. For the MLR, the formulation thinks more about the management of land; while the MOHURD focuses on the housing management. However, as for the management of real estate property concerns the content of housing and its appurtenant parcel, this adopted identification system of the SULBRD mainly extends the identification system of SUCD to a unified identification system of real estate (Yan, 2010).

5.3.1. The Identification System for Cadastral Database in the SUCD

In general, the identification system for cadastral database consists of five parts: identification of administrative division, identification of street/district, identification of street block, identification of parcel, branch identification of parcel. And the structure of identification system can be show as below.

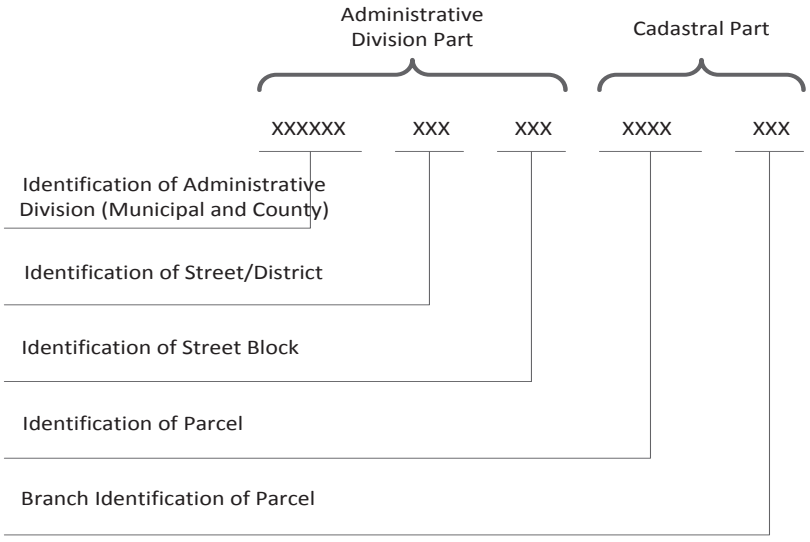

Figure 5-2 Structure of Identification System for the SUCD (in Ministry of Land and Resources (2007b))

According to this figure above, the cadastral identification is generally composed of the administrative division part and the cadastral part (19 digits). Among them, the last 7 digits comprise the parcel identification. If there is no branch identification for parcel, the last three numbers would be "000". And the identification for administrative division would refer to the Codes for the Administrative Divisions in China (General Administration of Quality Supervision Inspection and Quarantine of the People's Republic of China(AQSIQ) & Standardization Administration of the People's Republic of China(SAC), 2007).

5.3.2. The Identification System for Land and Housing Cadastral Database in the SULBRD

Considering the connection between land and housing cadastre, the identification system of the SULBRD was formulated on the basis of the SUCD, and then was extended to the combination of land and housing cadastre. In other word, the identification system for the land and housing cadastre consists of two main parts: one is the identification of land cadastre, and this part is more or less the same as the one in the SUCD; the other part is the identification of housing cadastre (15 digits), which is composed of identification of building, identification of building unit, identification of floor, and identification of room. And the structure of the identification system for the SULBRD is shown as follows.

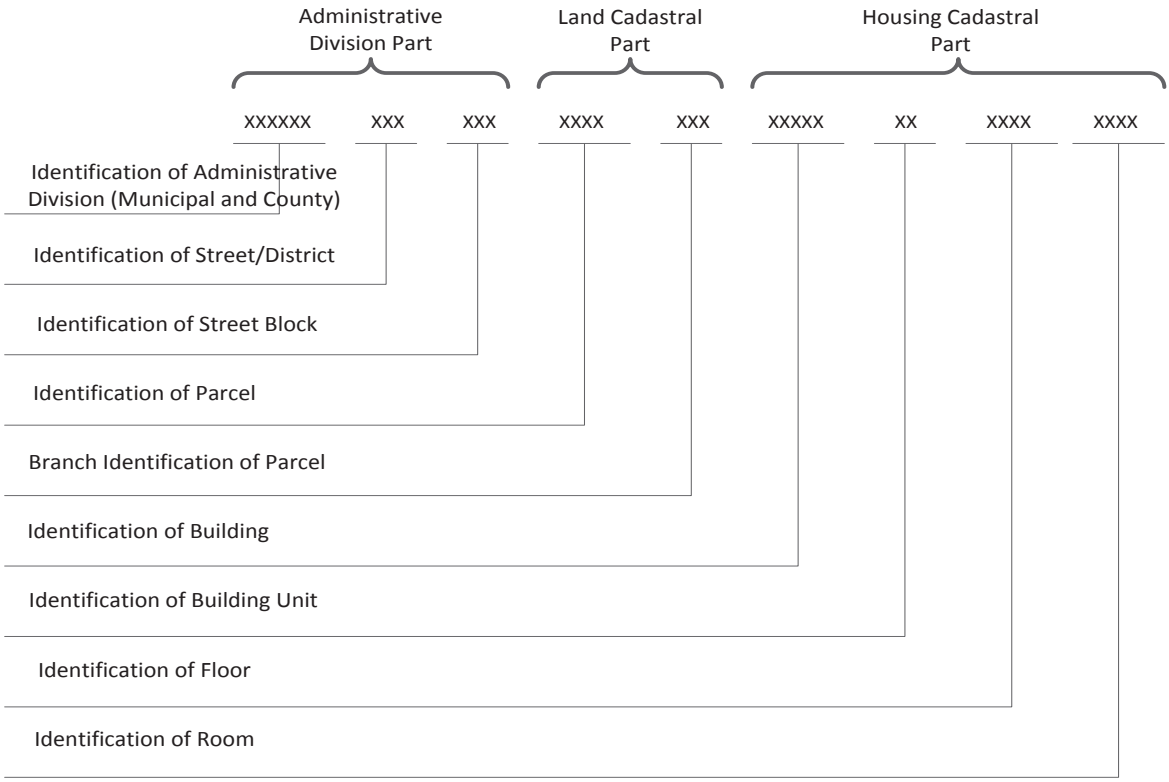

Figure 5-3 Structure of Identification System for the SULBRD (in Bureau of Land Resources and Housing in Chongqing Municipality (2010b))

Furthermore, by taking the LADM classes into consideration, the CN_BAUnit class serves as the complex object of real estate, which follows the structure above. That is to say, it also consists of three main parts: the housing cadastral part and land cadastral part and administrative division part. Meanwhile, these three parts are corresponding to housing class, parcel class and administrative area class respectively in the country profile, which will further discussed in the next section.

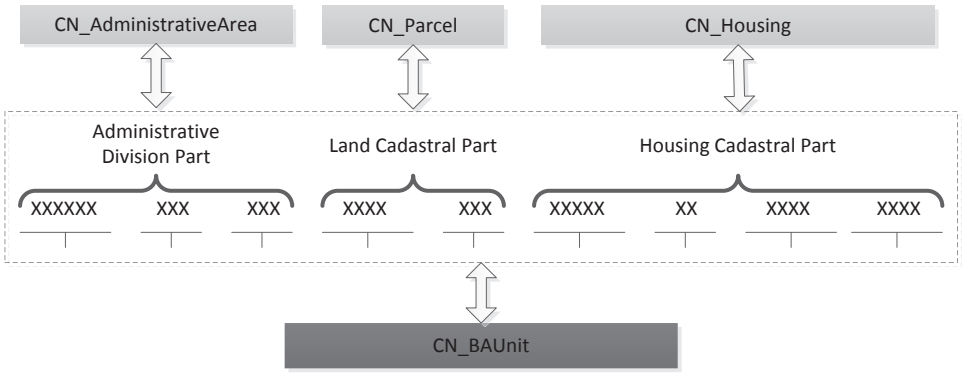

Figure 5-4 Corresponding Relationship between Identification System and LADM Classes

5.4. Content of the SULBRD in Chongqing Municipality

Specifically, according to Bureau of Land Resources and Housing in Chongqing Municipality (2010b), the content of this standard is categorized into six main layers: positioning basis, administrative regionalization,

physiognomy, land & housing tenure, land use and raster data. It is worth mentioning that land and housing tenure is the key feature brought about by this standard, as is shown in the table below. And due to the focus of this research are urban areas, the third and fifth layer will be left outside the research scope.

Table 5-1 Layer Classification of Spatial Features in the Land and Housing Database (in Bureau of Land Resources and Housing in Chongqing Municipality (2010b))

No.	Layer	Layer Feature	Geometrical Characteristic	Table Name	Constraint Condition
1	Positioning Basis	Control Point (CP)	Point	CLKZD	M
		Annotation of CP	Annotation	ZJ	O
2	Administrative Regionalization	Administrative Division	Polygon	XZQ	M
		Boundary of Administrative Division	Line	XZQJX	M
		Annotation of Administrative Feature	Annotation	ZJ	M
3	Physiognomy	Contour Line	Line	DGX	O
		Elevation Point with Notes	Point	GCZJD	O
4	Land & Housing Tenure	Parcel	Polygon	ZD	M
		Annotation of Parcel	Annotation	ZJ	M
		Parcel Boundary Line	Line	ZDJZX	M
		Annotation of Parcel Boundary Line	Annotation	ZJ	O
		Parcel Boundary Point	Point	ZDJZD	M
		Annotation of Parcel Boundary Point	Annotation	ZJ	O
		Building	Polygon	FWLZ	M
		Annotation of Building	Annotation	ZJ	O
		Building Cadastre	Polygon	QJLZ	M
		Annotation of Building Cadastre	Annotation	ZJ	O
		Building Boundary Line	Line	LZQJX	M
		Annotation of Building Boundary Line	Annotation	ZJ	O
		Building Boundary Point	Point	LZQJD	M
		Annotation of Building Boundary Point	Annotation	ZJ	O
5	Land Use	Patch of Land Class	Polygon	DLTB	M
		Linear Features	Line	XZDW	O
		Boundary of Land Class	Line	DLJX	M
		Annotation of Land Use Feature	Annotation	ZJ	M
6	Raster Data	Digital Orthophoto Map (DOM)	Image	SGSJ	O
		Digital Raster Graphic (DRG)	Image	SGSJ	O
		Digital Elevation Model (DEM)	Image /Tin	SGSJ	O
Note: For the Constraint Condition: M(Mandatory), O(Optional)					

More detailed information for these attributes has been put in Annex 3.

5.5. Proposed Data Structure for the Integrated Land and Housing Database

As is presented in Zhang et al. (2008), the fundamental relationship between land and person is a basic relationship that serves as core for the proposed Chinese Cadastral model. Based on these contents and descriptions above, the data model for such standard also can be transformed into the "people – land" relationship. Specifically, within the land administration domain, the key object is parcel, which can be further aggregated into patch of land class and administrative division (Zhang et al., 2008), while for housing administration, the main focus is the "mound – building – floor – room" framework (Y. Zeng, 2008). In order to introduce the integrated management of land and housing in China, Gao and Deng (2008) consider that the concept of parcel and mound is the same in general. In that case, the structure for integrated land and housing data model will become "parcel – building – floor – room". Then, as for the

subject class in this domain, Li et al. (2012) state that it can be generalized into natural and non-natural persons.

According to the Property Law of China, the real estate rights can be categorized into ownership, use right and security right (Li et al., 2012). Nevertheless, the focus of this research is the integrated land and housing management of urban areas in China. Therefore, the land property right system in urban areas is generally composed of state-owned land ownership, land use right and other rights(S. Chen, 2003).

Meanwhile, through synthesizing the foresaid China's land property right system and the content of the SULBRD above, the proposed real estate property right system generally consists of bundles of ownerships, use rights, and security rights. Specifically, the bundle of ownership refers to the land ownership and housing. For the use right part, it is noteworthy that it limits itself to construction land use right, land and housing easement and housing ownership (including the condominium ownership and co-ownership of common elements) when we focus on the urban land and housing administration domain in China. And then for the bundle of security rights, the mortgage right is the key security right in China, which is based on the land use right and housing ownership (Li et al., 2012). In addition, according to the Property Law, the preliminary notice primarily functions as a pre-emptive mechanism to ensure a future dealing with the registered owner. In that sense, the preliminary notice serves as a personal claim, i.e. turning obligatory interest into a property-like right with a pre-emptive feature (L. Chen, 2012). For the sake of fitting to the LADM standard, these kinds of rights can be generalized into right bundle, restriction bundle and pre-right bundle. And, the proposed real estate property right system can be shown as follows.

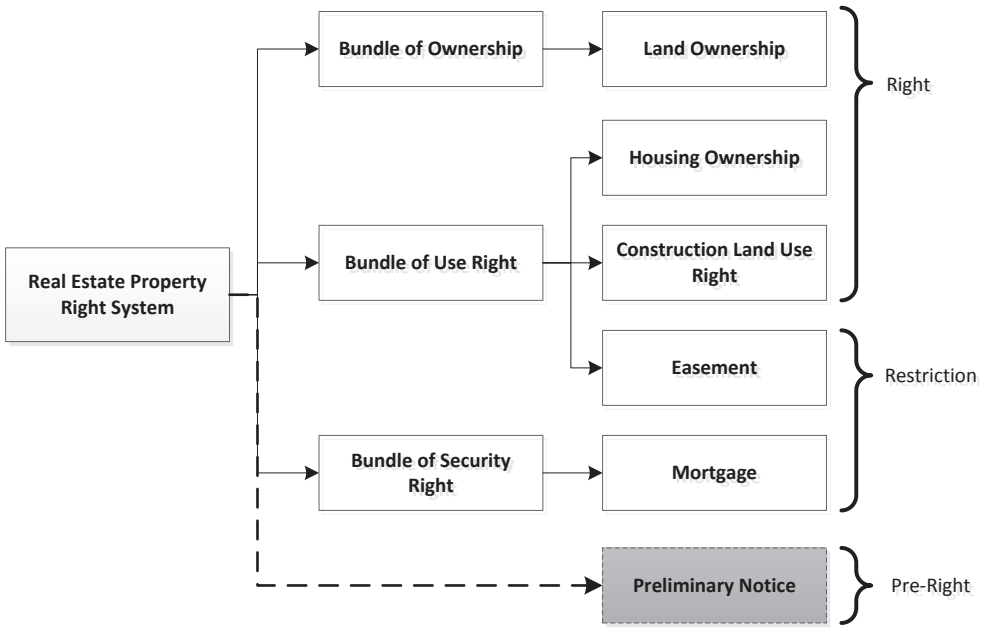

Figure 5-5 Proposed Real Estate Property Right System in Urban Areas of China

To sum up, the data model for the integrated land and housing database can be generated as follows.

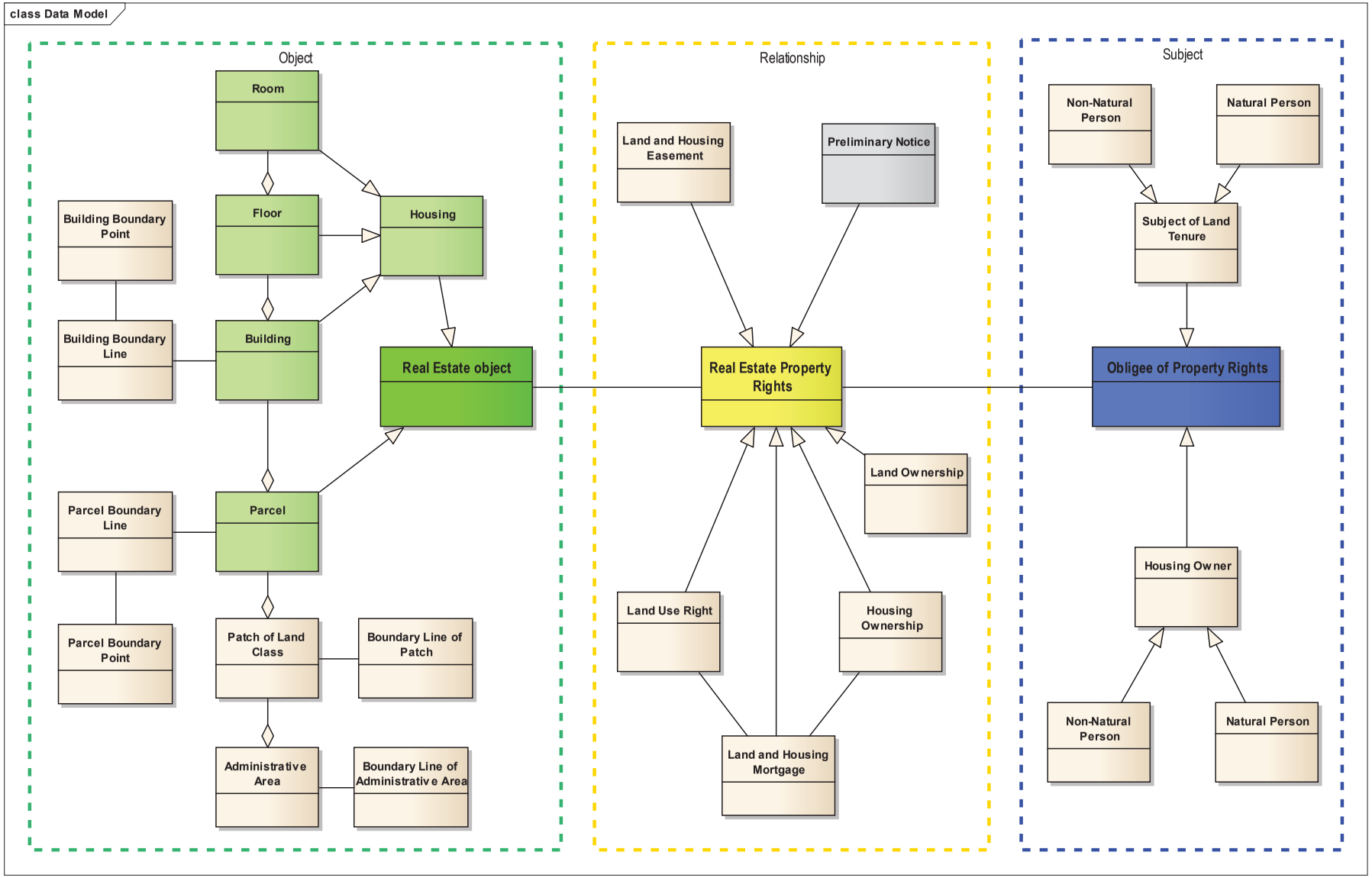

Figure 5-6 Existing Data Model of the Integrated Land and Housing Database

According to Figure 5-6 above, the green box refers to "object", the blue box circles the objects of "subject", and the yellow one means the relationship between them. Specifically, the key feature in this relationship is the real estate object, which consists of land object and housing object. Then the property right and subject of property right are developed based on this integrated concept of land and housing, namely real estate object.

5.6. Concluding Remarks

Up to this chapter, the analysis stage was completed. And this chapter has figured out the current structure for land and housing database in China, with a focus on Chongqing Municipality. Firstly, the land and housing management in Chongqing Municipality has been presented, as well as its adopted standard for land and housing database: the SULBRD. Secondly, the identification system for land and housing cadastral database was introduced. Finally, the content of the SULBRD and the proposed data structure for the integrated land and housing database were depicted. Based on those, the current structure for land and housing database was clear now, which took the Chongqing Municipality for example.

Based on the analysis results of this chapter and the previous one, the design chapter will start subsequently.

6. DESIGN OF LADM COUNTRY PROFILE FOR CHINA

6.1. Introduction

In the previous two chapters, the current and required structures for the land and housing database in China were studied and analysed. Following the research approach in chapter 3, after going through the analysis stage, this chapter is to focus on the design of the LADM country profile China, which will consist of two main steps: to migrate from legal requirements and the SULBRD classes to the LADM classes and to develop the LADM country profile China.

Specifically, section 6.2 transforms the required classes and attributes into the LADM context. Section 6.3 makes the comparison between chosen classes of LADM and SULBRD. This analysis will also take required classes and code lists of section 6.2 into consideration. The next section describes the relationships between these classes. Finally, following on these classes, code lists and relationships, the LADM country profile China will be developed subsequently.

6.2. Transformation from Legal requirements to the LADM Classes and Code Lists

According to the synthesis of user requirements in chapter 4, there are a number of classes and attributes generated from these requirements. While, in order to accomplish the design the LADM based data model for China, there is still a step further need to walk, which is to transform the required classes and attributes into the LADM context. The transformed results have been posed in Annex 4.

6.3. Comparison between Chosen Classes of LADM and the SULBRD

Based on the discussion previously, the structure for land and housing cadastral database in Chongqing Municipality has been studied, as well as those required classes and code lists from related legislations. Then in order to transform these classes into the LADM context, the following two sections will take a comparison between chosen classes of LADM and the SULBRD, and to illustrate corresponding relationships between them. Moreover, the transformed required classes and code lists of section 6.2 will be taken into consideration in the meantime.

First of all, as is mentioned in the introduction chapter, the scope of this thesis is limited to the urban land and housing cadastre in China. The rural and marine parts are outside this scope. So their corresponding classes, attributes and relationships will be eliminated then. Specifically, as for the administrative package, it is developed based on the urban real estate property right system (See Figure 5.5). In the spatial unit package and its surveying and representation subpackage, the rural part will be ignored, like the patch of land class, contour line, elevation point, etc.

With regard to the country profile China, it can be summarized into four main (sub) packages: party package, administrative package, spatial unit package and surveying and representation subpackage. However, for differentiating the Chinese country profile from others, this research will use 'CN' as the prefix for new classes and code lists in the country profile.

6.3.1. Special Classes

By referring to the LADM standard, these special classes like VersionedObject, Fraction, Oid and CN_Source will generally continue to use the LADM standard version (ISO/TC211, 2012). These special classes respectively cover following aspects: historical manipulation of data in the database, part-whole relationship, identifier data type, and prove documents within the land administration domain. In addition, in order to describe the common properties of spatial units, the CN_CommonSpatialUnit will be generated too. Meanwhile, the LA_Area class and LA_VolumeValue class are respectively used to illustrate the area and volume of different types in the land and housing administration. And these detailed explanations are shown as below.

- **Classes of Special Classes**

Table 6-1 Classes of Special Classes

LADM Classes and Data Types	**Explanations**	**Included Attributes**
VersionedObject	This class is to manage and maintain historical data in the database.	beginLifespanVersion/ endLifespanVersion/quality/source
Fraction	This generic data type is to provide support for fractions.	denominator/numerator
Oid	This class is to provide support for object identifiers.	localId/namespace
CN_Source	This is an abstract class, which includes administrative sources and spatial sources.	acceptance/availabilityStatus/ lifeSpanStamp/type/quality/ recordation/sID/source/submission
CN_CommonSpatialUnit	This class is to provide common properties of spatial units	area/surfaceRelation/location/ landUsage/relativeLocation/referencePoint
CN_Area	This is to illustrate the area of various types	areaValue/type
CN_ResponsibleParty	This refers to the responsible party	individualName/organizationName/ positionName/phone/address/role
CN_LandUsage	The land usage of different types	landUsage/type
CN_RelativeLocation	The relative location of adjoining parcels	name/direction

- **Code Lists for Special Classes**

Table 6-2 Code Lists for Special Classes

LADM Code Lists	**Explanations**	**Values**
CN_SourceType	refers to the media type of sources	graphical document/textual document
CN_AreaType	refers to the type of areas	administrative control area/administrative calculated area/parcel measured area/parcel certificated area/original parcel measured area/original parcel certificated area/land use area/building area (above, below, total)
CN_AvailabilityStatusType	refers to the availability status type of administrative sources	original/complete/incomplete/destroyed
CN_SurfaceRelationType	refers to the type of surface relation	on the surface/above the surface/below the surface
CN_RoleType	refers to the role type of responsible party	owner/user/legal representative/point of contact/surveyor/reviewer/registrar
CN_LandUseType	refers to the type of land use	Actual usage/approved usage
CN_DirectionType	refers to the type of direction	North/east/south/west
CN_LandUsage	refers to the type of land usage	Residential/land for water facilities/public service/special land/transport/commercial/warehousing/others (this thesis mainly focuses on the urban area, so here only mentioned the urban land use types)

6.3.2. Party Package

As is seen from the discussion in chapter 5 and detailed attribute structures in Annex 3, the party package plays as the role of subject in this research. Such subject can be generalized into two main kinds, which are natural person and nonNatural person. Furthermore, there are several specific kinds within the scope of this research, such as land user, housing owner, mortgagee, etc.

This research is to explore on the problem of land and housing integration. According to such domain, there are three basic classes for this package, which are CN_Party, CN_GroupParty, and CN_PartyMember. Here, the party class refers to the person or organization that plays a role in process. While, L. Chen (2007) summarized that condominium ownership is the individual ownership of a room coupled with a percentage of an undivided interest in the common elements. And all of the room owners also jointly own the shared land use right and co-ownership of common elements. Therefore, the classes of group party and party member are introduced, with an aim to these situations.

- **Classes of Party Package**

Table 6-3 Classes of Party Package

LADM Classes	Explanations	Classes in China
CN_Party	a person or organization that plays a role in rights	Land user/owner, housing owner, mortgagee/mortgagor, obligee/obligor of preliminary notice, responsible department, registrar
CN_GroupParty	a number of parties, forming together a distinct entity, with each party registered	The land use right and other common elements are owned jointly by all the housing owners.
CN_PartyMember	a constitutional party member among the group party	Housing owner for shared ownership of common elements, and housing owner for shared land use right

- **Code Lists for Party Package**

Table 6-4 Code Lists for Party Package

LADM Code Lists	Explanations	Values
CN_PartyRoleType	refers to the type of roles the party plays	land user/Housing owner mortgagee/mortgagor obligee/obligor of preliminary notice government official collective land owner/the state land/housing administration department
CN_GroupPartyType	refers to the type of group parties	parcel obligee (share land use right) building obligee (share the co-ownership of common elements)
CN_PartyType	refers to the type of parties	Group/natural person/nonNatural person

6.3.3. Administrative Package

As for the administrative package, the basic classes are CN_BAUnit and CN_RRR. It is worth mentioning that the CN_BAUnit plays as a key function for the integration of land and housing databases, which refers to the real estate object (including land and housing object). And the CN_RRR is an abstract class that describes these related rights and restrictions to the real estate object. Generally, according to the SULBRD and these related legislations, the RRR class includes several specializations, like land use right, land ownership, housing ownership, mortgage, easement, preliminary notice and so on. And all of these (except preliminary notice) can be categorized into classes of restriction and property right. In regard to the preliminary notice, L. Chen (2012) stated that it serves as a pre-emptive mechanism to safeguard the owner against the third party from engaging a future dealing with the registered owner. Due to its special feature and unique code lists, this thesis introduces a pre-right class, which functions in the circumstance of suspending the registration and preserve the status quo. Moreover, the property right class and restriction class respectively have further specializations: land ownership subclass and mortgage subclass.

Furthermore, during the procedure of land and housing administration, a number of administrative documents should be submitted or generated. In that case, the CN_AdministrativeSource will be need. And it will be used to store the documents, such as certificates of land use right and housing ownership, application form, identification materials.

- **Classes of Administrative Package**

Table 6-5 Classes of Administrative Package

LADM Classes	Explanations	Classes in China
CN_BAUnit	administrative entity consisting of zero or more spatial units against which unique and homogeneous rights, responsibilities or restrictions are associated to the whole entity	The LA_BAUnit in the LADM country profile China refers to the real estate object, which consists of land and housing object.
CN_RRR	an instance of a subclass of RRR is a right, or restriction	In this standard, the main focus is: rights, pre-right, and restrictions.
CN_PropertyRight	action, activity or class of actions that a system participant may perform on or using an associated resource	This class in this thesis concerns three main parts: land ownership, land use right and housing ownership.
CN_Ownership	An instance of the Right Class, which refers to the bundle of ownership.	This class refers to the land ownership in this research.
CN_PreRight	An instance of the RRR Class, which illustrates the property like right in reality.	Such class severs as a property like right in China. And the preliminary notice is a typical example.
CN_Restriction	obligations to refrain from doing something	In this research, this is would be an abstract class, which has two specializations: land and housing mortgage and easement.
CN_Mortgage	a specialization of CN_Restriction	This class refers to the land and housing mortgage, preliminary notice mortgage, and others.
CN_AdministrativeSource	source with the administrative description of the parties involved, the rights, restrictions and responsibilities created and the basic administrative units affected	It includes the sources for the certificates of parties, RRRs and basic administrative units.

- **Code Lists for Administrative Package**

Table 6-6 Code Lists for Administrative Package

LADM Code Lists	Explanations	Values
CN_OwnershipType	refers to the type of ownerships of the parcel	state-owned/collective
CN_RightType	refers to the type of use rights	temporary land use right/land use right/ housing ownership/condominium ownership/co-ownership of common elements/land ownership
CN_DisposalType	refers to the method of disposal for the use rights	alienating/exchanging/using as equity contribution/endowing/expropriating
CN_PreRightType	refers to the type of pre-rights	preliminary notice of advanced-purchased commercial housing/preliminary notice of setting mortgage on advanced-purchased commercial housing/preliminary notice of housing ownership maintenance/preliminary notice of

		housing ownership mortgage (Ministry of Construction (formly Ministry of Housing and Urban-Rural Development), 2008)
CN_RestrictionType	refers to the type of restrictions	Right of way easement/support of structures easement/mortgage
CN_MortgageType	refers to the type of mortgage	Land and housing mortgage/maximum mortgage/mortgage of under-construction project
CN_BAUnitType	refers to the type of basic administrative unit	Basic property unit/basic right unit. This thesis only focuses on the right unit.
CN_AdministrativeSourceType	refers to type of administrative sources	application form/identification material/certificate of land use right/certificate of housing ownership/alternation document/tax paid proof/tax reliefs proof/construction planning permit/document of as-built inspection of building/ approval document/mortgage contract/Master obligatory right contract/certificate of real estate/construction schedule/ permit of advanced sale

- **New Attributes for Administrative Package**

Table 6-7 New Attributes for Administrative Package

LADM Attributes	**Explanations**	**Value Types**
piece	refers to the piece number of real estate objects	Integer (the piece number)
beginTerm	refers to start time of a term for a right or restrict in reality	DateTime
endTerm	refers to end time of a term for a right or restrict in reality	DateTime
funds	refers to the funds put for construction	Currency
investment	refers to the total budgetary investment of the project	Currency
percent	refers to the percent for the total budgetary investment	Decimal
completion	refers to the completion date of the construction project	DateTime
stID (private)	refers to the identification of servient tenement	Oid
dtID (private)	refers to the identification of dominant tenement	Oid
approval	refers to the date of approval by responsible departments	DateTime

6.3.4. Spatial Unit Package

For this package, it is the concrete description for the basic administrative unit. In other words, it refers to its compositions. And it consists of two levels: the land level and housing level. First of all, for the land level, the basic unit for land administration is parcel (Ministry of Land and Resources, 2007a). While, for the housing administration, the fundamental entity is the 'mound – building – floor – room' framework (Jiang, 2007). Then, considering that the contents of parcel and mound are generally consistent, Y. Zeng (2008) proposes the structure for the integrated data model, which is 'parcel – building – floor – room'. And the relationship among them is 'contains'. In other words, all these relationships can be presented as the kind of aggregation with '1: M' multiplicities in Unified Modelling Language (UML). Meanwhile, according to the SULBRD, there are five main objects: parcel, building, building unit, floor and room. Here, in this thesis the building class and building unit class will be combined and to be treated as one

entity in the model, and the identifier of the building is composed of the identifiers of the building unit and its appurtenant building.

As you see, based on such structure, this package has four basic classes: parcel class, building class, floor class and room class. As is mentioned above, the focus of this research is the urban cadastre in China, so the rural part of cadastre, like patch of land class, will be eliminated then. In addition, the administrative area plays as a group of parcel based spatial unit, which is considered as a group spatial unit class.

Furthermore, the CN_Level class refers to a set of spatial units with a certain level of coherence, which functions the same as the concept of layer. And in this research, the level class is used to illustrate the two components of real estate basic administrative unit.: one level is for parcel, and the other level is for housing, which can be further divided into building, floor and room unit.

Finally, it is worth noting that according to discussion in chapter 5, the composition of their identifiers can be expressed as: bauID = aaID + supID + suhID (= buildingNo + floorNo + roomNo). And in order to create the link between the integrated data model and original data models, it is necessary to introduce the original identifiers. Moreover, as for the housing database, according to the research of Yang (2011), the identifiers of mapsheet, mound, building, floor and room are used for the 'mapsheet – mound – building – floor – room' structure. While the existing cadastral database choses to use the identifier of parcel in China (Ministry of Land and Resources, 2007b). In conclusion, the identifier of mapsheet shall still be used, and all the other identifiers will still be kept in the integrated data model as the original ones for the linking use.

- **Classes of Spatial Unit Package**

Table 6-8 Classes of Spatial Unit Package

LADM Classes	**Explanations**	**Classes in China**
CN_Housing	single area (or multiple areas) of land and/or housing	Generally, land cadastre and housing cadastre are two main kinds of spatial units in this research.
CN_Parcel		
CN_AdministrativeArea	a number of parcel based spatial units, considered as an entity	Administrative area
CN_Building	instances of the subclasses of housing	There classes refer to the components of housing, which are building unit, floor, and room.
CN_Floor		
CN_Room		
CN_Level	set of spatial units, with a geometric, and/or topological, and/or thematic coherence	One level of spatial units is for parcel, another is for building.

- **Code Lists for Spatial Unit Package**

Table 6-9 Code Lists for Spatial Unit Package

LADM Code Lists	**Explanations**	**Values**
CN_HousingUseType	refers to the type of housing use	Residential/complete residential/normal residential/economically affordable housing/luxury villas/non-residential, non-complete residential/official/commercial/parking/warehousing/ industrial/others
CN_HousingNatureType	refers to the type of housing nature	economically affordable housing/low-rent housing/houses built on the funds collected by the buyers/others
CN_HousingStructureType	refers to the type of housing structure	steel structure/reinforced concrete structure/steel and reinforced concrete structure/masonry-timber structure/mixed structure/other structures
CN_LandGradeType	refers to the type of land	Composite (grade 1~12)/commercial (grade 1~12)/residential (grade 1~12)/industrial (grade

	grade	1~12)
CN_RoomLayoutType	refers to the type of room layout	Single Apartment/Studio Apartment/one(two, three, four)-bedroom & one(two, three)-dining room/more than five-bedroom
CN_RegisterType	refers to the type of register	initial register/maintenance register/mortgage register easement/preliminary notice/nullification register/compensation register
CN_LevelContentType	refers to the type of level class	land cadastre/housing cadastre
CN_StructureType	refers to the structure of the level geometry	point/line/polygon

- **New Attributes for Spatial Unit Package**

Table 6-10 New Attributes for Spatial Unit Package

LADM Attributes	Explanations	Value Types
commence	refers to the start date of the construction project	DateTime
built	refers to the end date of the construction project	DateTime
volume	indicates the volume value of the covered space	volume
suhID	refers to the identifier of the housing spatial unit	Oid (15)
floors	refers to the total number of floors in a building unit	integer
replacementPrice	refers to the replacement price of the housing unit	Currency
supID	refers to the identifier of the parcel based spatial unit	Oid (7)
acquiredPrice	refers to the acquired price of the parcel based spatial unit	Currency
landTax	refers to the tax value for the parcel based spatial unit	Currency
compensationFees	refers to the compensation fee of for the expropriated land	Currency
purposeExpropriated	refers to the purpose of the expropriated land	CharacterString
standardLandPrice	refers to the standard land price of the parcel	Currency
nominalLandPrice	refers to the nominal land price of the parcel	Currency
aaID	refers to the identifier of the administrative area	Oid (5)
buildingSetNum	refers to the room set number within the building unit	integer
buildingNo	refers to the No. of both building and building unit (if there is no building unit in the building, the last two no. should be '00')	Oid (5+2)
floorSetNum	refers to the room set number on the floor	integer
remarkableFloor	refers to the remark for the floor	CharacterString
floorNo	refers to the No. of the floor	Oid (4)
roomNo	refers to the No. of the room	Oid (4)
roomArea	refers to the building area of the room	area
msID	refers to the identifier of the mapsheet	Oid
opID	refers to the identifier of parcel in the original database	Oid
omID	refers to the identifier of mound in the original database	Oid
obNo	refers to the No. of building in the original database	Oid
ofNo	refers to the No. of the floor in the original database	Oid
orNo	refers to the No. of the room in the original database	Oid
Note: The msID will be put in the administrative area class. While, the omID, and opID will be kept in the parcel class. Then the obNo, ofNo and orNo will be added to the classes from building to room.		

6.3.5. Surveying and Representation SubPackage

Currently, in China, the survey department, namely National Administration of Surveying, Mapping and Geoinformation (SBSM), is one of the departments under the MLR. And the SBSM is responsible for

several survey issues, such as enacting relevant regulations and rules, arranging cadastral surveying and mapping, arranging housing surveying and mapping, auditing the competent and authenticate surveying companies or organizations, etc. (National Administration of Surveying Mapping and Geoinformation (SBSM), 1994, 2001). That is to say that cadastral surveying and mapping will be carried out and managed by the cooperation of the cadastral department under the MLR and the SBSM. While as for housing surveying and mapping will be taken charge by the cooperation of the MOHURD and the SBSM. And the organizational mechanism for these three departments can be shown as follow.

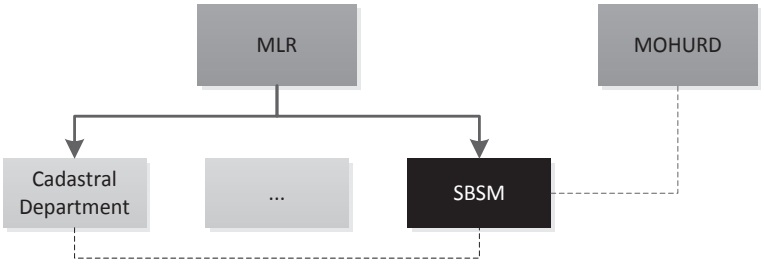

Figure 6-1 Organization Mechanism for SBSM, MLR and MOHURD

Due to such kind of separate surveying for land and housing respectively, a number of problems will arise, like duplicate surveying, waste of human resource and money (Wu, 2002). Thus, this research will put these two kinds of data into an integrated schema. In other words, the boundary face string class and point class will be utilized to store the surveying data of both land parcel and housing.

This subpackage of surveying and representation shall be used to represent both the land and housing surveying relevant classes, with an association to the spatial unit package. In general, the boundary face string, point and spatial source are three basic classes for this package. In this package, there are two main kinds of boundary face strings: boundary face string and administrative boundary face string. Meanwhile, the point class has a specialization, namely control point. In addition, the class of transAndResults is needed to realize the transformation of coordinates between two reference systems, because Beijing Geodetic Coordinate System (GCS) 1954 and Xi'an GCS 1980 are two main coordinate reference systems in cadastral survey and mapping nationwide (Liu, 2007). Meanwhile, all these related documents and measurements will be depicted in the spatial source class.

- **Classes of Surveying and Representation SubPackage**

Table 6-11 Classes of Surveying and Representation SubPackage

LADM Classes & Data Types	**Explanations**	**Classes in China/included attributes**
CN_Point	0-dimensional geometric primitive, representing a position. Points can be observed by terrestrial surveying, photo interpretation, image interpretation, or identification on an existing map	Control point, analytic property point, graphical property point, others
CN_ControlPoint	the control point in the cadastral survey, it is a specialization of class CN_Point	Control point
CN_SpatialSource	source with the spatial representation of one (part of) or more spatial units	Spatial sources include survey plan, satellite images, and vector maps and so on.
CN_BoundaryFaceString	boundary forming part of the outside of a spatial unit	Parcel boundary line, housing boundary line
CN_AABoundaryFaceString	boundary of the administrative area, which is an instance of boundary face string	administrative area boundary line
CN_Transformation	the transformations of coordinates	transformation/transformedLocation

	between two reference systems	

- **Code Lists for Surveying and Representation SubPackage**

Table 6-12 Code Lists for Surveying and Representation SubPackage

LADM Code Lists	Explanations	Values
CN_BoundaryFaceStringType	refers to the type of the boundary face string among land, housing and administrative area	parcel boundary line, housing boundary line
CN_BoundaryLineType	refers to the type of the land and housing boundary line in reality	Wall, fence, wire mesh, drip line, road limit line, point-point, and others
CN_BoundaryLineLocation	refers to the location of boundary line dealing with the physical boundary line	Left, mid, and right
CN_BoundaryLineNature	refers to the property type of the administrative area boundary line	Defined boundary, undefined boundary, disputed boundary, working boundary, others
CN_AdministrativeBoundaryType	refers to the type of the administrative area boundary line	Coastline, mean high water spring tide(MHWST), zero meters contour, demarcation line between land and sea, national boundary, provincial boundary, municipal boundary, county boundary, town boundary, development zone boundary, and village boundary
CN_PointType	refers to the type of the point among land, housing and administrative area	Control point, analytic property point, graphical property point, others
CN_LandMarkType (private)	refers to the type of the landmark	Steel nail, cement column, lime pile, spraying, porcelain mark, no mark, others
CN_ControlPointType	refers to the type of the control point	Survey control point, horizontal control point, geodetic origin, triangulation point, mapping control point, traverse point, vertical control point, levelling origin, benchmark, satellite positioning control point, Satellite positioning ranking point
CN_ControlPointRanking	refers to the ranking of control point	1st level/2nd level/3rd level/4th level
CN_MonumentationType	refers to the monumentation type of the control point	Basement, concrete, normal, others
CN_MarkType	refers to the type of mark on the monumentation	Copper mark, steel mark, cross-carved mark, and others
CN_ControlPointStatus	indicates the status of control point	well-preserved, part-destroyed, destroyed, others
CN_SpatialSourceType	refers to the type of the spatial source	Survey plan, parcel sketch, housing door map, housing floor map, building map, description of point, boundary agreement, boundary

		reason book, and others
CN_InterpolationType	The role of the point in the straight line or curve	Start End isolate
Note: for more detailed information about the type and ranking of control points, it can be referred to 'Specification for Global Positioning System (GPS) Surveys' GB/T18314-2009 (National Administraiton of Surveying Mapping and Geoinformation(SBSM), 2009).		

- **New Attributes of Spatial Unit Package**

Table 6-13 New Attributes of Spatial Unit Package

LADM Attributes	Explanations	Value Types
aaDescription	the description of the administrative boundary	CharacterString
aabfsID	the identifier of the administrative boundary	Oid

6.4. Relationships between Classes

By referring to the standard of ISO/TC211 (2012), the relationships between the classes can be categorized into four kinds: association, generalization, aggregation. And for these relationships, they generally consist of three main parts: the first two parts are the inheritance from the LADM standard and some new generated relationships. And the other part is the eliminated relationships for the country profile China.

6.4.1. Associations between the LADM Classes

According to Eriksson et al. (2009), the association is a connection between classes, which means that it is also a connection between objects of those classes. It is defined as a semantic connection among a tuple of object. And for this section, it consists of three parts: inheritance from the LADM standard, new associations for the country profile China, and omitted associations between these classes, which can be shown as follows.

- Inheritance from the LADM standard

Table 6-14 Inheritance from the LADM standard (Adapted from ISO/TC211 (2012))

Class 1	Class 2	Association name	Role name End 1	Multiplicity	Role name End 2	Multiplicity
Party	RRR	rrrParty	party	0..1	rrr	0..*
Party	GroupParty	members	parties	2..*	group	0..1
Party	Administrative Source	subjectSource	subject	1..*	source	0..*
Party	SpatialSource	surveyorSource	surveyor	1..*	source	0..*
RRR	BAUnit	rrrBAUnit	rrr	1..*	baunit	1
RRR	Administrative Source	rrrSource	rrr	0..*	source	1..*
BAUnit	Administrative Source	unitSource	baunit	0..*	source	0..*
BAUnit	SpatialSource	baunitSource	baunit	0..*	source	0..*
Mortgage	PropertyRight	mortgageRight	mortgage	0..*	right	0..*
BoundaryFaceString	SpatialSource	bfsSource	bfs	0..*	source	0..*
BoundaryFaceString	Point	bfsPoint	bfs	0..*	point	0,2..*
Point	SpatialSource	pointSource	point	1..*	source	0..*

- New Associations for the country profile China

Table 6-15 New Associations for the country profile China

Class 1	**Class 2**	**Association name**	**Role name End 1**	**Multiplicity**	**Role name End 2**	**Multiplicity**
BAUnit	Housing	baunitHousing	baunit	0..*	spatialunit	0..*
BAUnit	Parcel	baunitParcel	baunit	0..*	spatialunit	0..*
Housing	Level	housingLevel	spatialunit	0..*	level	0..1
Housing	SpatialSource	housingSource	spatialunit	0..*	source	0..*
Parcel	Level	parcelLevel	spatialunit	0..*	level	0..1
Parcel	Administrative Area	parcelAA	part	0..*	whole	0..*
Parcel	SpatialSource	parcelSource	spatialunit	0..*	source	0..*
Parcel	BoundaryFaceString	pplus	spatialunit	0..*	bfs	0..*
Parcel	BoundaryFaceString	pminus	spatialunit	0..*	bfs	0..*
Administrative Area	AABoundaryFaceString	aaAAbfs	spatialunit	0..*	aabfs	0..*
Building	BoundaryFaceString	bplus	spatialunit	0..*	bfs	0..*
Building	BoundaryFaceString	bminus	spatialunit	0..*	bfs	0..*

- Eliminated Associations between the LADM Classes

Table 6-16 Eliminated Associations between the LADM Classes (in ISO/TC211 (2012))

Class 1	**Class 2**	**Association name**	**Role name End 1**	**Multiplicity**	**Role name End 2**	**Multiplicity**
Administrative Source	RequiredRelationshipBAUnit	relationSource	source	0..*	requiredRelationBaunit	0..*
BAUnit	BAUnit	relationBaunit	unit1	0..*	unit2	0..*
BoundaryFace	SpatialSource	bfSource	bf	0..*	source	0..*
BoundaryFace	SpatialUnit	minus	bf	0..*	su	0..*
BoundaryFace	SpatialUnit	plus	bf	0..*	su	0..*
Party	BAUnit	baunitAsParty	party	0..*	unit	0..*
Point	BoundaryFace	pointBf	point	0,3..*	bf	0..*
SpatialSource	RequiredRelationship-SpatialUnit	relationSource	source	0..*	requiredRelationshipSu	0..*
SpatialUnit	Point	referencePoint	su	0..1	point	0..1
SpatialUnit	SpatialUnit	relationSu	su1	0..*	su2	0..*

SpatialUnit	SpatialUnit	suHierarchy	su1	0..*	su2	0..1
SpatialUnitGroup	SpatialUnitGroup	suGroupHierarchy	element	0..*	set	0..1

In conclusion, the key features for the association relation are the spatial unit package, which generally consists of two main objects: parcel and housing spatial unit. And the space related descriptions are outside the scope of this research, so its related association relationships will be eliminated. Meanwhile, the baunit class will not play as the role of party, so this relationship is not included too (See Table 6-16). Then, for the rest part of the association relationships, these are mainly inherited from the LADM standard, which is shown in Table 6-14.

6.4.2. Generalizations between the LADM Classes

As is also stated in Eriksson et al. (2009), the generalization is a relationship between a more general and a more specific element. In other words, it describes a relationship between groups of things with something in common. The key feature of such relationship is that it allows inheritance from a parent class to a child class. And the child class only contains additional information. As for the China's land administration domain, it will also be divided into three parts, which is just the same as the relationship of association.

Table 6-17 Generalizations in the Country Profile China

Category	**Superclass**	**Subclass**
Inheritance from the LADM Standard	Party	GroupParty
	RRR	Restriction
	RRR	PropertyRight
	Restriction	Mortgage
	VersionedObject	RRR
	VersionedObject	BAUnit
	VersionedObject	Party
	VersionedObject	PartyMember
	VersionedObject	Level
	VersionedObject	BoundaryFaceString
	VersionedObject	Point
	Source	AdministrativeSource
	Source	SpatialSource
New Generalizations	Housing	Room
	Housing	Floor
	Housing	Building
	RRR	PreRight
	PropertyRight	Ownership
	Point	ControlPoint
	VersionedObject	Housing
	VersionedObject	Parcel
	VersionedObject	AdministrativeArea
	VersionedObject	AABoundaryFaceString
	CommonSpatialUnit	Housing
	CommonSpatialUnit	Parcel
Eliminated Generalizations	RRR	Responsibility
	VersionedObject	BoundaryFace
	VersionedObject	RequiredRelationshipBAUnit
	VersionedObject	RequiredRelationshipSpatialUnit

To sum up, owing to the same reasons as the association relationship, the eliminated generalization relationships are of space related descriptions and new added ones are about the spatial unit package. Moreover, this research introduces the CommonSpatialUnit Class as the common property for the spatial unit classes. So this is another new added part. And the responsibility class is outside the scope of this research, so its related generalization will be deleted too.

6.4.3. Aggregations between the LADM Classes

Generally, aggregation is a special case of association, which indicates that the relationship between the classes is some sort of 'whole – part' (Eriksson et al., 2009). Specifically, in the country profile China, the aggregation relationship exists between party and group party, and among the 'building – floor – room' framework, which is shown in the table below.

Table 6-18 Aggregations between the LADM Classes

Class 1	Class 2	Role name End 1	Multiplicity	Role name End 2	Multiplicity
Party	GroupParty	parties	2..*	group	0..*
Room	Floor	element	1..*	set	1
Floor	Building	element	1..*	set	1
Building	Parcel	object	0..*	base	1

6.5. Desgin of the LADM Country Profile China

Generally, according to the previous two sections, the LADM country profile for China's Land and Housing Cadastral Database (LHCD) can be developed by referring to the ISO/TC211 (2012). And for each of the packages, the detailed classes and their corresponding attributes can be discovered too. Therefore, the next design of country profile will go through two main steps: one is the detailed design of each separate (sub) package and the other part is to design the package overview of country profile China.

6.5.1. LADM Country Profile China Overview of (Sub) Packages

Based on the analysis and comparison above, the country profile China is generally composed of three packages, one subpackage and several special classes, as follows.

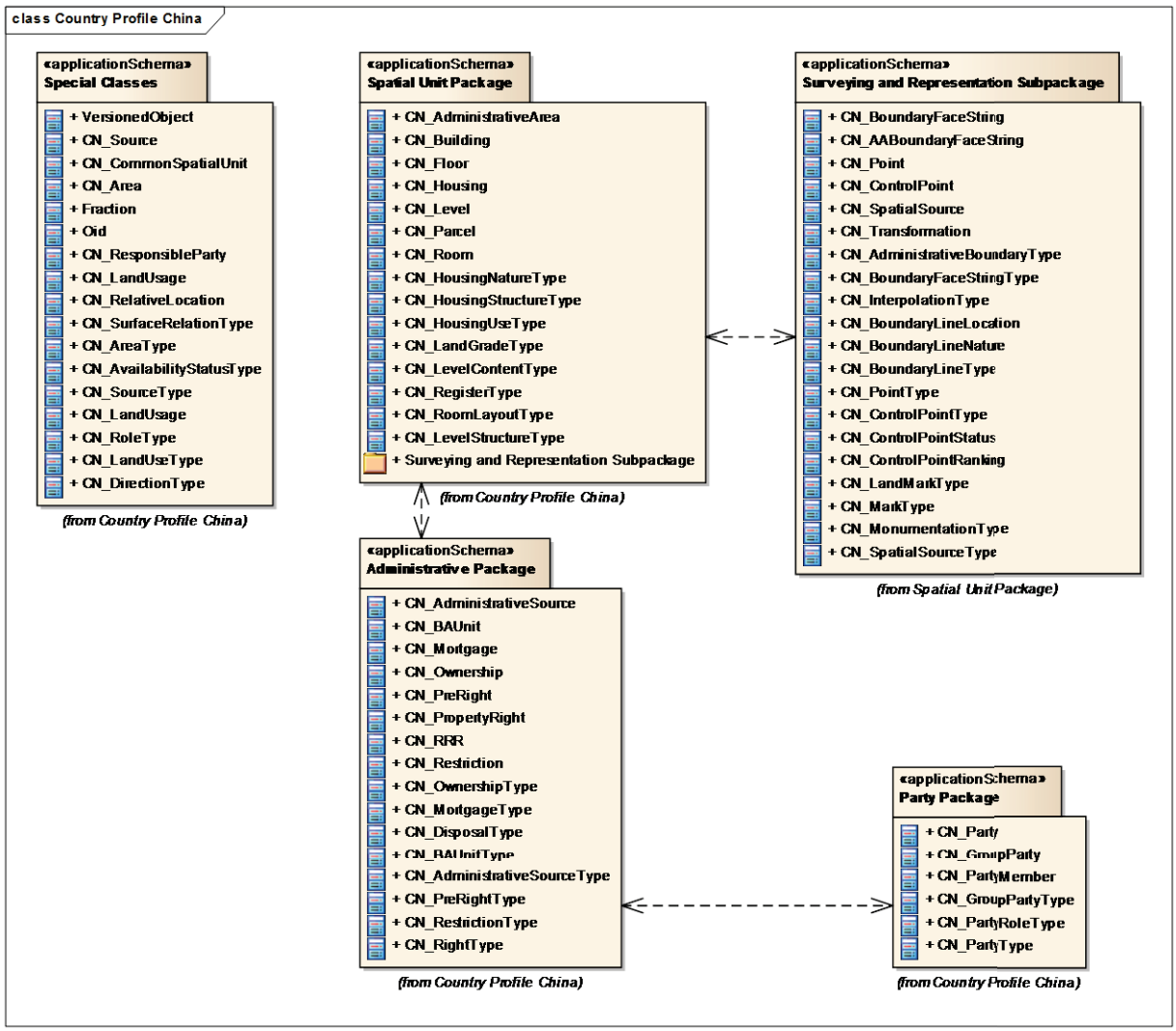

Figure 6-2 The LADM Country Profile China overview of (sub) Packages (with Special Classes)

6.5.2. Special Classes

According to discussion in section 6.3.1, there are three special classes and several data types introduced in this country profile, which are used to represent historical aspect, part-whole relationship, identifier data type, prove documents and common properties for special unit within the land administration domain. For these three special classes, the class diagrams have been respectively posed below.

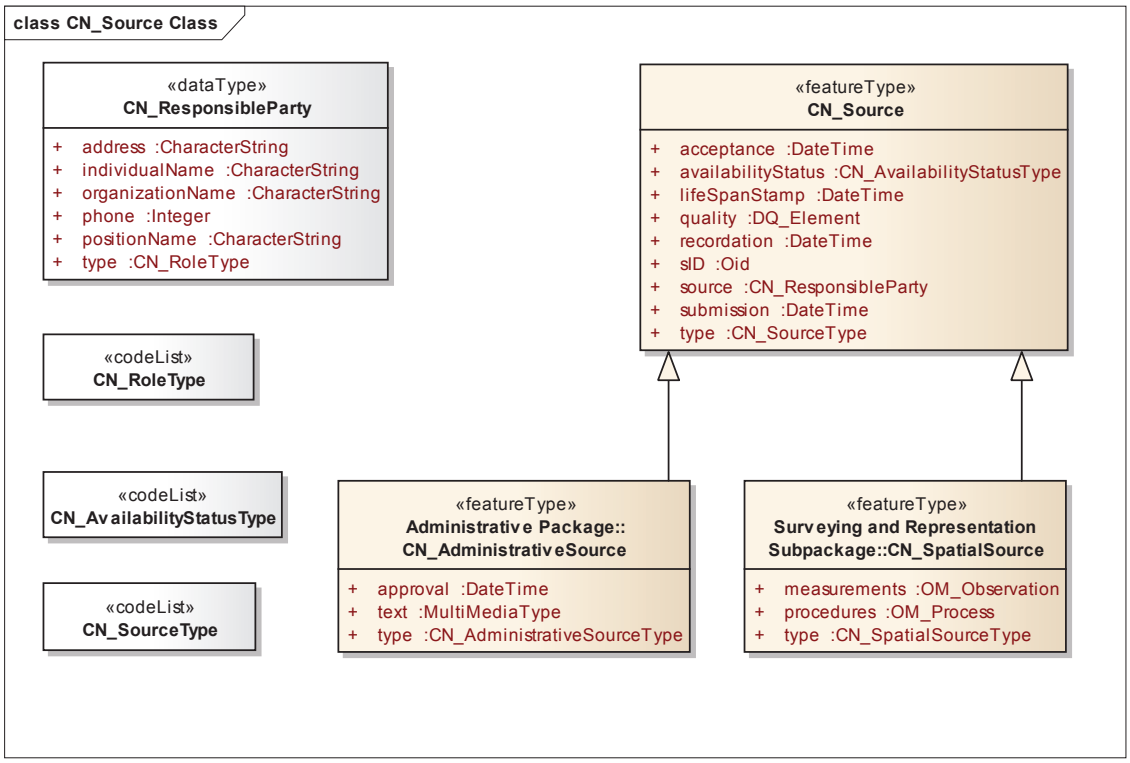

Figure 6-3 Class CN_Source

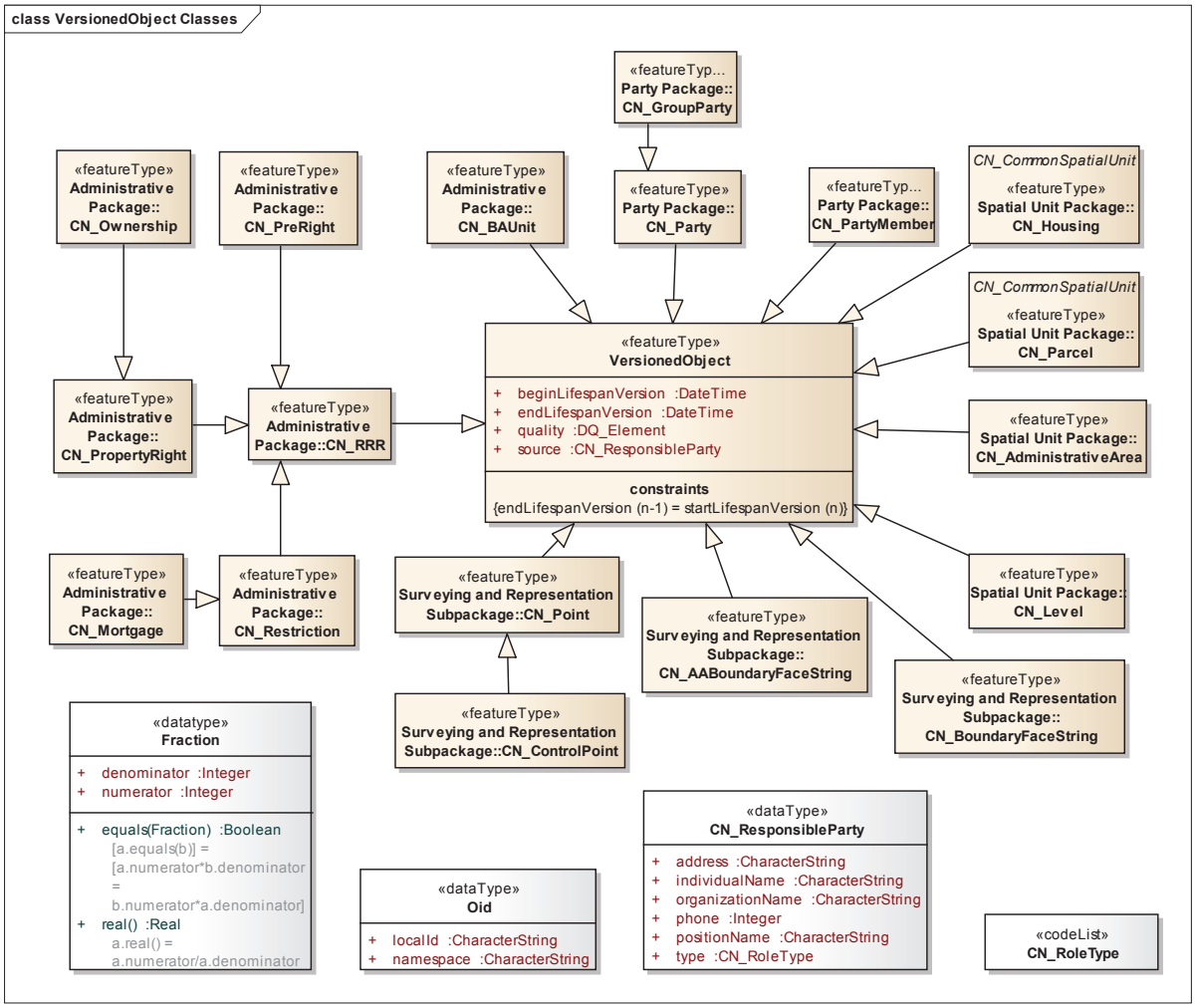

Figure 6-4 Classes VersionedObject

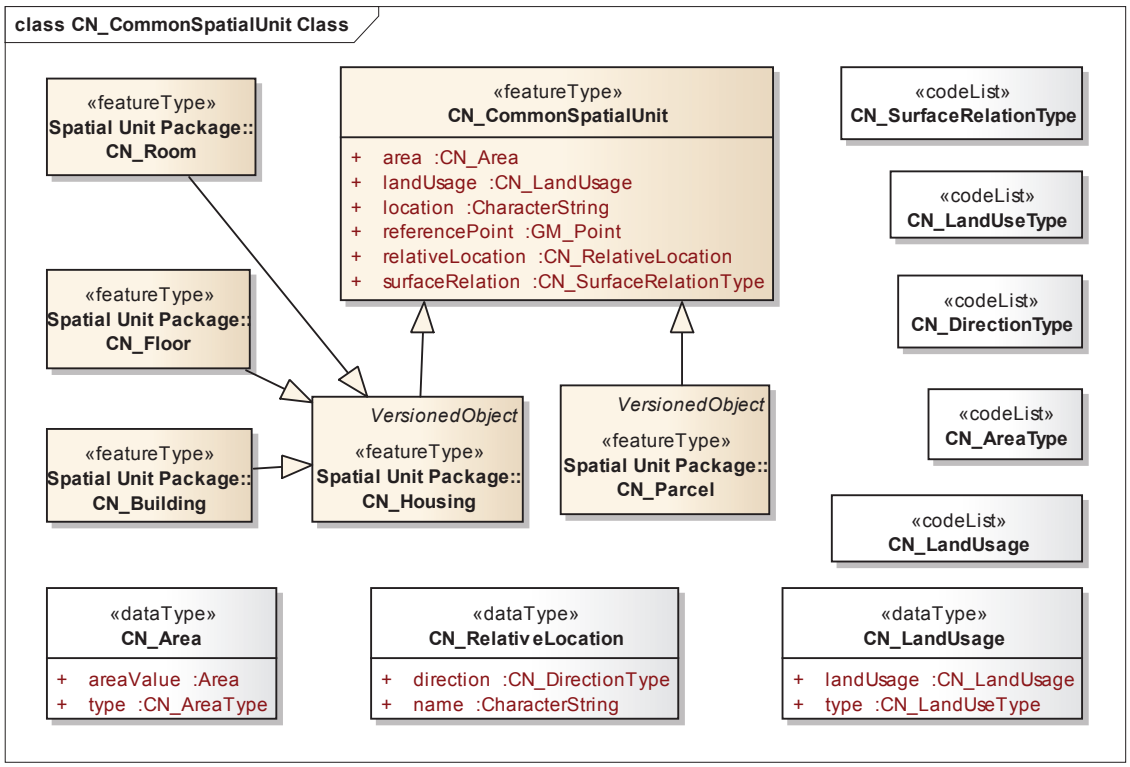

Figure 6-5 Class CN_CommonSpatialUnit

6.5.3. Party Package

According to the SULBRD and transformation of legal requirements, the content of party package contains the core classes LA_Party, LA_GroupParty, and LA_PartyMember. And the content and associations of Party Package can be presented as follows:

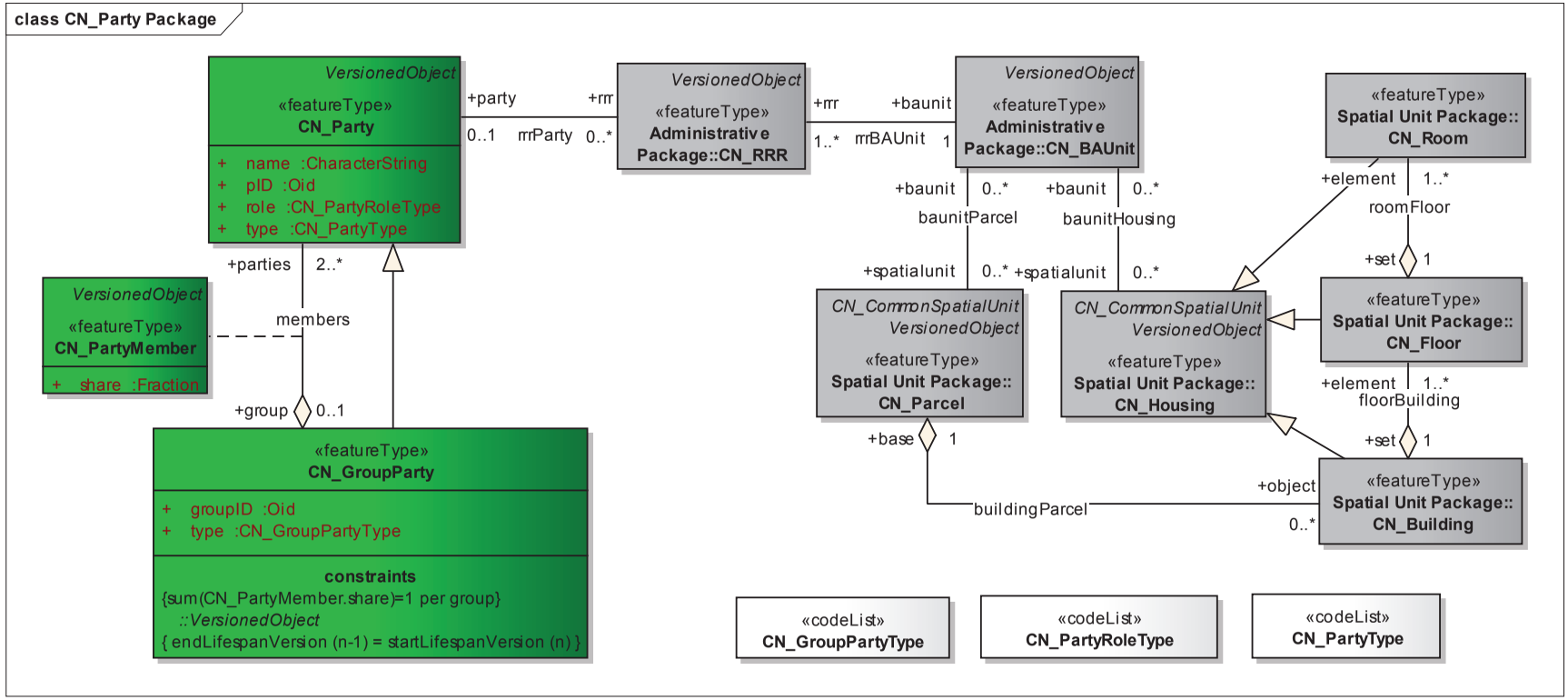

Figure 6-6 Content of the Party Package with Relationships

6.5.4. Administrative Package

As is presented in the previous section, the main classes of this package are RRR and BAUnit. And for the RRR class, there are three specializations, which are restriction, property right and pre-right. Such content of the RRR class are generated on the basis of the real estate property right system, as is shown in Figure 5-6. Moreover, the BAUnit class refers to the real estate object and the administrative source class is included in this research.

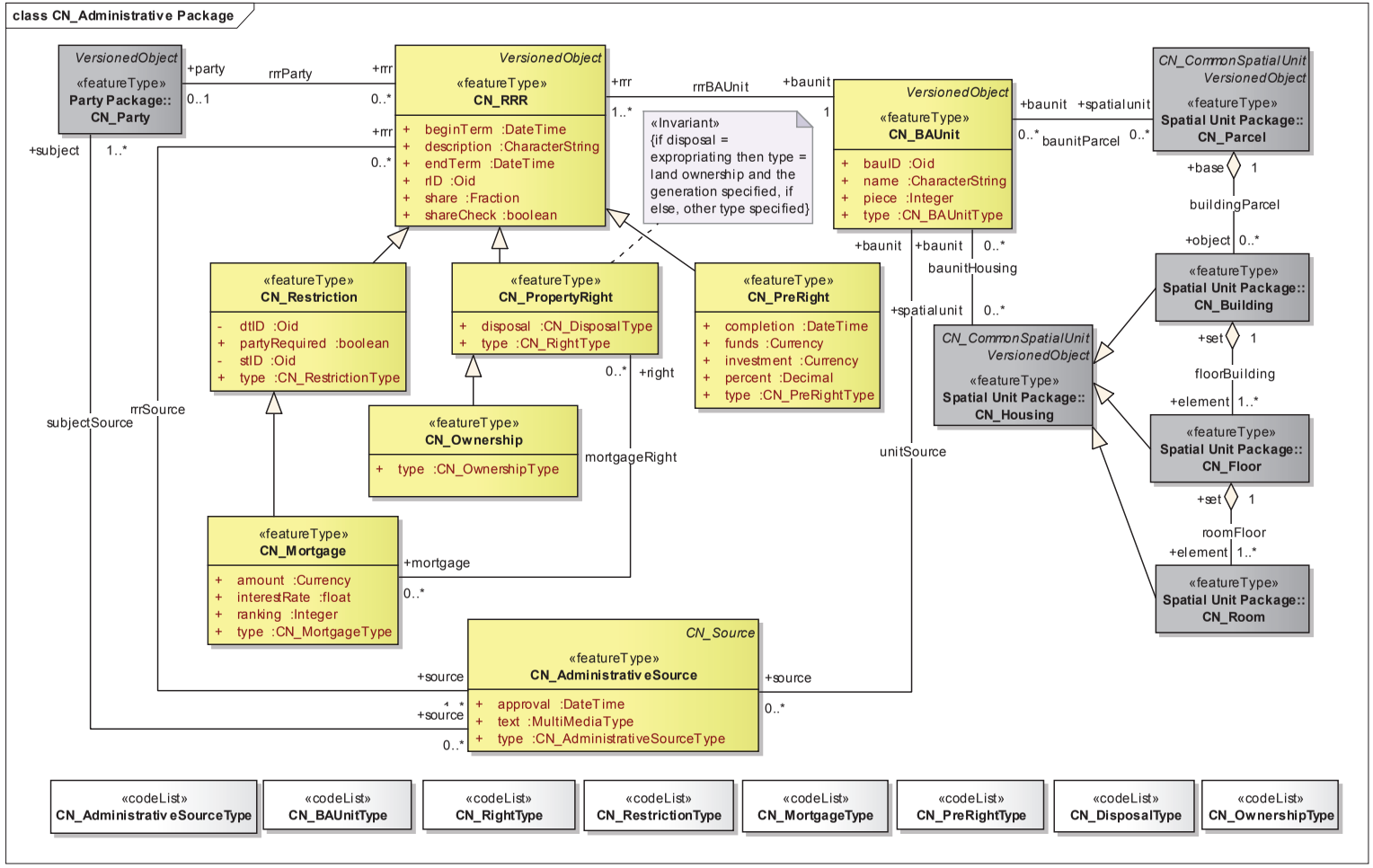

Figure 6-7 Content of the Administrative Package with Relationships

6.5.5. Spatial Unit Package

In this research, one of the key features for the spatial unit package is the combination of parcel and housing unit. And the other is the constitutions of the housing unit and their relationships with the parcel unit. Moreover, the level class is introduced to describe level concept for this research problem: one is for housing and the other is for land.

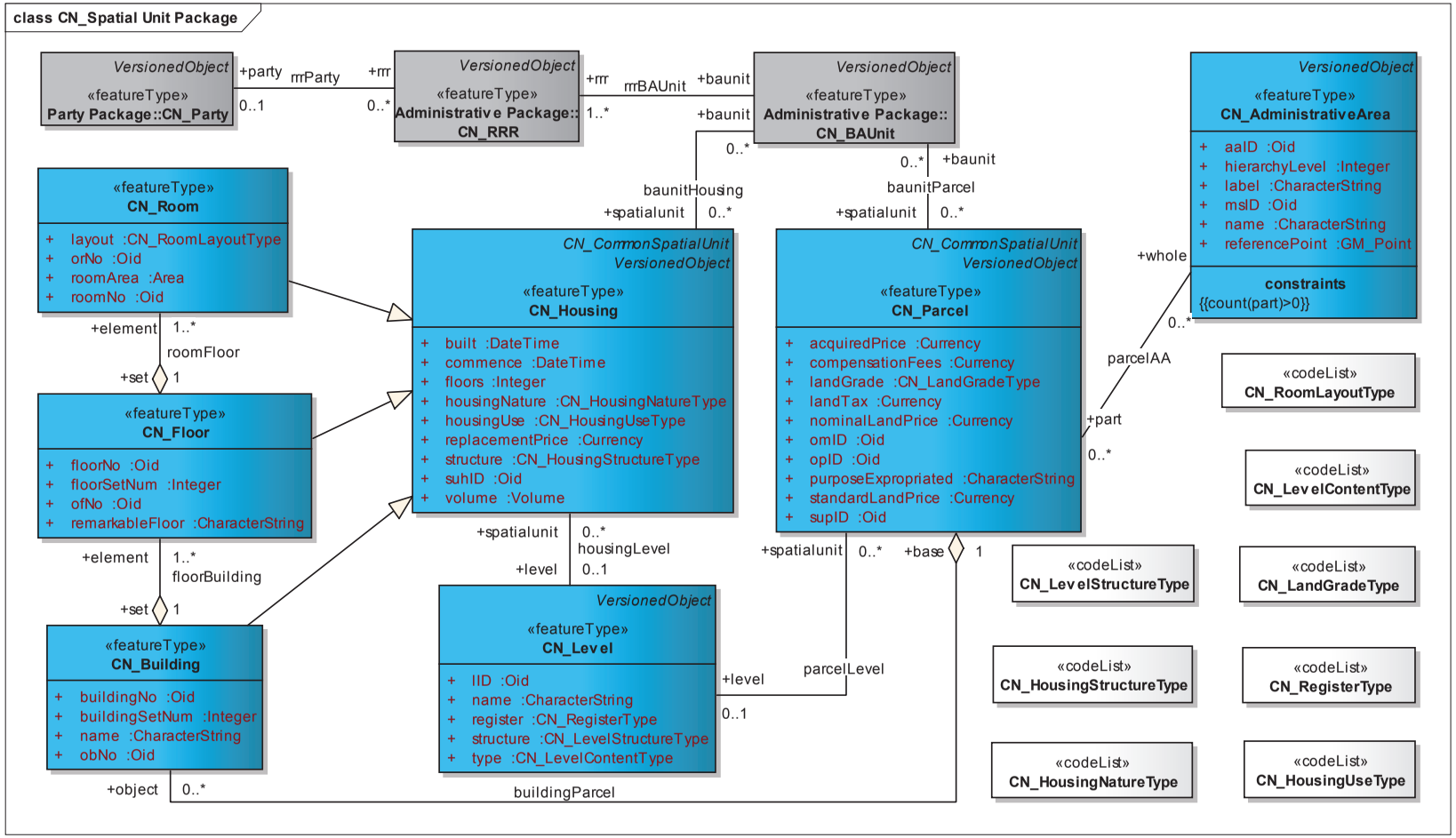

Figure 6-8 Content of the Spatial Unit Package with Relationships

6.5.6. Surveying and Representation SubPackage

Then, for the surveying and representation package, its content is composed of the boundary line, point and related documents. Owing to the focus of this research is the urban land and housing administration. There would be only urban features evolved.

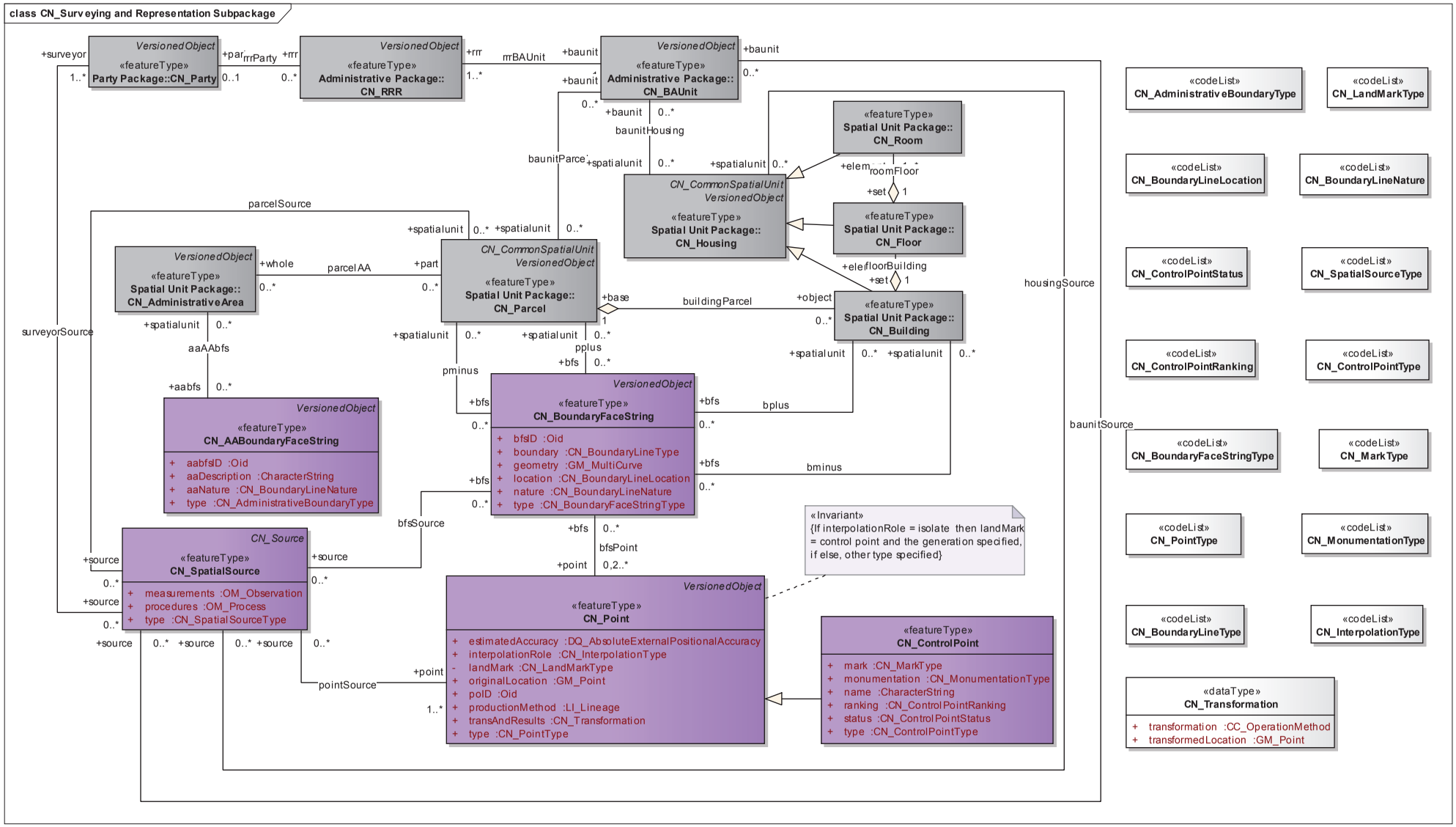

Figure 6-9 Content of the Surveying and Representation Subpackage with Relationship

6.6. Concluding Remarks

Based on the analysis results above, this chapter tries to design the LADM country profile for China. And it can be generally divided into two steps: transformation of chosen classes and design of the country profile. Regarding the first step, legal requirements were transformed into LADM classes in advance. Then the comparison between chosen classes of the LADM and the SULBRD was carried out, as well as the relationships and multiplicities between these classes. Up to this part, classes, attributes, code lists of both require and existing has already been transformed into LADM classes, as well as the relationships and multiplicities.

Then the second step was started. Derived from the preparations above, the LADM country profile for China was developed. Specifically, a number of special classes and four (sub) packages were designed in the Enterprise Architect by using the UML.

After developing the country profile, it is necessary to carry out an evaluation framework for it. Therefore, it will be arranged in the next chapter.

7. EVALUATION OF LADM-COUNTRY PROFILE FOR CHINA

7.1. Introduction

As is stated in chapter 3, there are three main parts of this research: analysis, design and evaluation. And the focus of this chapter will be move to the evaluation of the LADM country profile China following the design stage of chapter 6.

In general, the evaluation framework consists of two main parts: one is to verify those legal requirements which are collected from related legislations. And the other part is the abstract test suite for the country profile. Then based on the results of the evaluation, the discussion section will be developed in section 7.3.

7.2. Development of the Evaluation Framework

As is presented in the beginning, this research is to solve the dilemma between the current situation and social needs for the integration of land and housing databases in China. Meanwhile, according to the research approach in chapter 3, the core of this research will go through three main phases, which are analysis, design and evaluation. Up to this chapter, the first two stages have been covered. Specifically, the legal needs and existing structure for the land and housing database in China have been analysed, and then the LADM country profile China is developed based on these analysis outputs. Subsequently, according to the research approach, the next evaluation phase is to accomplish two main missions: the achievement verification of legal requirements and compliancy examination of the country profile.

Therefore, this evaluation framework will generally be composed of the following two suites: the verification of legal requirements and the conformance test of the country profile.

7.2.1. Verification of Legal Requirements

According to the research approach in chapter 3, this verification suite will be established on the basis of these required classes and attributes in Annex 4. In order to verify these legal requirements, these verification criteria will be categorized into packages accordingly. And then corresponding attributes and No. will be picked out too. Subsequently, using the country profile China as a reference, the achievement test will be carried out then, which is shown as below.

Table 7-1 Legal Requirements Verification Suite

Verification Criteria		**No.**	**Covered?**
LADM Class	**LADM Attributes**		
Source	recordation	1-2, 1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1, 9-10, 9-11, 10-2, 10-3	C
	acceptance	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
	lifeSpanStamp	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
	sID	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
	submission	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-1, 5-5, 5-6, 7-1, 13-1	C
	availabilityStatus	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
	type	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
	source	1-4, 1-6, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 7-1	C
VersionedObject	source	1-7	C
Common-SpatialUnit	area	1-9, 1-10, 9-6, 13-4, 13-5	C
	landUsage	1-9, 1-10, 2-2, 9-8, 10-6, 13-4, 13-5	C
	location	1-10, 13-5	C
	type	8-4	C
Party	name	1-7, 1-9, 2-1, 2-3, 2-4, 3-4, 3-5, 4-1, 4-2, 5-2, 5-6, 5-7, 7-2, 8-5, 9-5, 10-1, 10-4, 12-9, 12-10, 13-2, 13-4, 13-6	C
	role		
	type		

GroupParty	type	4-1	C
PartyMember	share	4-1	C
RRR	description	1-1, 8-1, 8-6	C
	rID	1-1, 5-3, 5-8, 8-1	C
	beginTerm	1-8, 1-9, 2-1, 2-3, 3-3, 5-6, 8-2, 9-3, 10-2, 10-8, 10-9, 12-10, 13-3, 13-4	C
	endTerm	1-8, 1-9, 2-1, 2-3, 3-3, 5-6, 8-2, 9-3, 10-8, 12-10, 13-3, 13-4	C
PropertyRight	type	1-1, 1-8, 1-9, 2-1, 2-3, 5-6, 8-1, 8-4, 8-6, 9-10, 9-11, 10-8, 10-9, 13-3, 13-4	C
	disposal	9-4, 9-10, 9-11	C
Restriction	partyRequired	3-3	C
	type		
PreRight	type	12-4, 12-8	C
	funds	12-4	C
	investment		
	percent		
	completion	12-6	C
Ownership	type	1-9, 2-1, 5-6, 10-3, 13-4	C
Mortgage	amount	3-3	C
	interestRate		
	ranking		
	type		
Administrative-Source	text	1-4, 1-6, 5-6	C
	type	1-4, 1-11, 2-5, 2-6, 3-1, 5-5, 5-6, 10-5, 12-2, 12-3, 12-5, 12-7, 12-8	C
	approval	5-6	C
BAUnit	piece	6-1	C
	bauID	13-7	C
Administrative-Area	aaID	1-3, 5-4	C
	name		
	hierarchyLevel		
Parcel	supID	1-9, 1-10, 9-9, 13-4, 13-5	C
	acquiredPrice	1-10, 8-3, 9-1, 9-9, 10-10, 12-1, 13-5	C
	landTax	9-2, 9-9	C
	compensationFees	10-7	C
	purposeExpropriated	10-11	C
	standardLandPrice	11-1	C
	nominalLandPrice	11-2	C
Housing	commence	3-2	C
	built		
	volume	9-7	C
	replacementPrice	11-3	C
Level	register	10-3	C
SpatialSource	type	1-5	C
	measurements		
	procedures		
BoundaryFace-String	type	1-10, 9-6, 13-5	C
	boundary		
	nature		
Note: covered value: Covered (C), not Covered (NC)			

Following the verification test, the results have been put in table 7-1 above. According to these results, we can figure out that almost all of these requirements have been covered.

7.2.2. Abstract Test Suite (ATS)

As is stated before, the LADM standard only defines the conceptual schema for the land administration domain. While the country profile China provides an application schema of the LADM, which is the actual use of this schema. After the development of country profile, the conformant of such specific application schema need to be examined in terms of package and level. Moreover, according to Annex A of the LADM standard, the abstract test suite can be specified for this conformance test for each package of the LADM country profile for China.

According to the international standard for conformance and testing, this ATS will be represented as a hierarchical structure of test modules, which is decomposed on the basis of test purposes (ISO/TC 211, 2000). Meanwhile, as is stated in the standard of LADM, the ATS in this thesis also consists of three levels of conformance for the LADM package. Thus, in this thesis, the abstract test suite will be developed which is corresponding to conformance levels. A higher conformance level includes all the requirements of a lower level. That is to say, it consists of three conformance test suites for each level correspondingly. As for the conformance test, it will be carried out on interdependencies between applicable packages. The mandatory and optional attributes are given in the class diagrams, as well as the same holds for associations (ISO/TC211, 2012).

- **Abstract Test Suite for Conformance Level 1 (Low Level)**

As is present in the LADM standard, the level 1 ATS tests the requirements for the implementation of package shall contain at least one of the basic classes of the LADM. While the LADM model contains 4 basic classes corresponding to packages, which are CN_Party, CN_RRR, CN_BAUnit, and CN_SpatialUnit (CN_Parcel and CN_Housing are two specializations). Therefore, this first level ATS will be established on the basis of these basic classes, as well as some special classes in the country profile. That means these following classes will be involved in this test: VersionedObject, CN_Source, CN_CommonSpatialUnit, CN_Party, CN_BAUnit, CN_PropertyRight, CN_SpatialUnit (which specifically refers to CN_Parcel and CN_Housing).

Table 7-2 Conformance Test Suite Level 1

LADM package	LADM class	Dependencies	Conformity
-	*VersionedObject*		C
	CN_Source	Oid, CN_ResponsibleParty, CN_AdministrativeSource (as a minimum, this specialization much be implemented)	C
	CN_CommonSpatialUnit	CN_Parcel/CN_Housing (as a minimum, one of these specializations much be implemented)	C
Party Package		Exist only if Administrative Package is implemented	
	CN_Party	VersionedObject, Oid, CN_PartyType	C
Administrative Package		Exist only if Party Package is implemented	
	CN_RRR	VersionedObject, Oid, CN_Party, CN_BAUnit, CN_PropertyRight (as a minimum, this specialization much be implemented), CN_AdministrativeSource	C
	CN_PropertyRight	CN_RRR, CN_RightType	C
	CN_BAUnit	VersionedObject, Oid, CN_RRR,	C

		CN_BAUnitType	
	CN_AdministrativeSource	CN_Source, CN_Party, CN_AdministrativeSourceType, CN_AvailabilityStatusType	C
Spatial Unit Package			
	CN_Parcel/CN_Housing	VersionedObject, Oid, CN_CommonSpatialUnit, CN_SpatialSource	C
Note: conformity values: Conformant (C), Not Conformant (NC), and Not Evaluated (NE), hereafter inclusive.			

As is shown in the table above, the test case for each package has been passed successfully. In other words, this country profile is level 1 compliant.

- **Abstract Test Suite for Conformance Level 2 (Medium Level)**

For this ATS, the LADM standard defines that the implementation of the package under the test shall contain at least the basic classes and the more common classes of the LADM. Here, these chosen common classes are generally on the basis of the LADM standard, which include: CN_AdministrativeSource, CN_BoundaryFaceString, CN_GroupParty, CN_PartyMember, CN_Point, CN_Restriction, CN_SpatialSource and CN_SpatialUnitGroup (which refers to CN_AdministrativeArea in this research).

Table 7-3 Conformance Test Suite Level 2

LADM package	**LADM class**	**Dependencies**	**Conformity**
Party Package		Exist only if Administrative Package is implemented	
	CN_GroupParty	VersionedObject, Oid, CN_PartyType, CN_GroupPartyType	C
	CN_PartyMember	VersionedObject, CN_PartyType, CN_GroupPartyType	C
Administrative Package		Exist only if Party Package is implemented	
	CN_Restriction	CN_RRR, CN_RestrictionType	C
Spatial Unit Package			
	CN_AdministrativeArea	VersionedObject, Oid, CN_Parcel	C
	CN_Level	VersionedObject, Oid, CN_RegisterType	C
Surveying and Representation Subpackage			
	CN_Point	VersionedObject, Oid, CN_SpatialSource, CN_PointType, CN_InterpolationType	C
	CN_SpatialSource	CN_Source, CN_Point, CN_Party, CN_SpatialUnit, CN_SpatialSourceType	C
	CN_BoundaryFaceString	VersionedObject, Oid, CN_Point	C

According to the test result in Table 7-3, all these common classes for conformance level 2 have be passed successfully. Therefore, based on the results of both level 1 and level 2, the country profile is level 2 compliant.

- **Abstract Test Suite for Conformance Level 3 (High Level)**

As for the ATS for conformance level 3, the implementation of the package under test shall contain all the other classes of the LADM shall be included besides the basic and common classes. Therefore, the rest classes of the country profile China will be examined in this suite as below.

Table 7-4 Conformance Test Suite Level 3

LADM package	LADM class	Dependencies	Conformity
Administrative Package			
	CN_Mortgage	CN_Restriction	C
	CN_Ownership	CN_PropertyRight	C
	CN_PreRight	CN_RRR, CN_PreRightType	C
Spatial Unit Package			
	CN_Building	CN_Housing	C
	CN_Floor	CN_Housing	C
	CN_Room	CN_Housing	C
Surveying and Representation Subpackage			
	CN_AABoundaryFaceString	VersionedObject, Oid	C
	CN_ControlPoint	CN_Point	C

As is depicted in the test suite above, all of these specializations for the classes of level 1 and level 2 have taken the conformant value. So the level 3 conformity is also achieved.

7.3. Discussion of the LADM Country Profile China

First of all, according to the results of verification suite in section 7.2.1, all of required classes and attributes have been covered in this country profile for China. Therefore, as for requirements, this country profile has satisfied all these legal requirements in general, which were collected from related laws and regulations. In other words, the integration problem of land and housing databases in China has been solved in the conceptual level through the LADM country profile for China.

Secondly, as is depicted by the ATSs in section 7.2.2, classes with level 1, 2 and 3 indicators have been passing the conformance test. Thus, these packages of this country profile for China are all level 3 compliant. Correspondingly, this country profile is conformant with the LADM standard. Furthermore, these requirements for each conformance level have been tested and passed successfully.

7.4. Concluding Remarks

This chapter developed an evaluation framework for the country profile China. Specifically, such framework consists of two main suites: verification suite of legal requirements and abstract test suite. Firstly, the verification suite was developed on the basis of legal requirements. While the abstract test suite was carried out through referring to the LADM standard. After the implementation of this evaluation, the discussion section was arranged then. According to this discussion section, all of these legal requirements were covered, and the country profile were also level 3 compliant based on the abstract test suite.

After complete the evaluation part, the next chapter will give a review on all of these research questions. And recommendations will be proposed too.

8. CONCLUSION AND RECOMMENDATIONS

8.1. Introduction

This chapter provides the conclusion and recommendations based on the research findings as described in previous chapters. Specifically, the first part is to give a review of research questions under each objective. Then section 8.3 will present several recommendations for the implementation of this country profile for China and further research.

8.2. Conclusion

According to the description in the introduction chapter, these research questions will be reviewed correspondingly, as follows.

- **Analysis**

Q1: What is the legal system in relation to land and housing administration in China?

The current land legal system for China has been described in the beginning of chapter 4. According to such description, we can see that the existing land legal system is composed of 7 layers, which specifies constitution, land laws, land statutes, local land statutes, land regulations, local land regulations and land standards. And such order also presents the ranking of land relevant legislations in China (See Figure 4-1).

Q2: What are the legal requirements for modelling of land and housing information involved relevant legislations?

According to the mechanism of land legal system above, integration related laws and regulations were picked out. For more details, we can refer to Table 4-1.

After picking out related legislations for the integration of land and housing information, there was a detail step need to go. Specifically, the main task of chapter 4 is to figure out some related articles from these legislations above, which has been put in Annex 1. Then, based on these picked-out articles, the legal requirements were synthesized accordingly in the end of chapter 4 (See Table 4-2).

Q3: What is the current structure for land and housing database in China?

As for the analysis of current situation, this thesis took Chongqing Municipality as a case study. Therefore, the SULBRD was the main data source here. Firstly, its key feature of the SULBRD is that it contains information of both land and housing. Correspondingly, the identification system added the housing part to the identification system of the SUCD (See Figure 5-3). Its content also has been presented generally in Table 5-1, and in details in Annex 3.

Through an explicit discussion, the existing structure for land and housing integrated database was proposed then (See Figure 5-6).

- **Design**

Q1: How can these legal requirements be transformed into the LADM classes?

Q2: What are the comparison results between chosen classes of LADM and SULBRD?

Q3: What are relationships and multiplicities between classes derived from Q1 and Q2?

First of all, based on the synthesis of legal requirements in chapter 4, a transformation (a preparation for the design) of the legal requirements into LADM classes, attributes or code lists was carried out. A complete overview of this is presented in Annex 4.

Then, as for chosen classes of the SULBRD, a comparison procedure was performed by referring these transformation output above at the meantime. These results have been shown in chapter 6, as well as these relationships and multiplicities between them.

After the preparation above, the design task was carried out subsequently. And the content of classes for each package and the package overview has been put in chapter 6 too.

- **Evaluation**

Q1: What are compositions of the evaluation framework?

The adopted evaluation framework was generally composed of two main parts: the requirements verification suite and abstract test suite for the country profile China.

Q2: Does this country profile complete those legal requirements?

According to the transformation of legal requirements in chapter 6, the verification suite was created. And generally, as is shown by the verification result, all of these legal requirements were covered.

Q3: Is this country profile conformant with the LADM in terms of package and level?

According to the Annex A in the LADM standard, the abstract test suite for this chapter was arranged into three conformance levels. Moreover, the results depicted that this country profile for China was level 3 compliant.

In conclusion, all of these research questions were answered, as remarked above. And regarding to the general goal of this research and hypothesis, this research developed an LADM country profile for China, with a focus on the land and housing database integration. That is to say that the general goal of this research has been achieved and the hypothesis posed before was proved as well.

8.3. Recommendations

Generally, the recommendations for this thesis contain two main parts:

1. To implement the LADM country profile for China

Due to limitation of time, this research did not cover the implementation part. Therefore, when applying such country profile for China, it is necessary to:

- Develop the China country profile on appropriate platforms,
- Convert existing data sets,
- Complete those data sets where needed,
- Test the maintenance of those datasets in a pilot environment, and:
- Evaluate the results.
- Under the research project of 'Free/Libre Open Source Software (FLOSS) Cadastre', which is carried out under the cooperation between Food and Agriculture Organization (FAO) and FIG Working Group 7.3, the Social Tenure Domain Model (STDM3) application has already been developed using open-source software (Steudler et al., 2010). Based on this knowledge, the FLOSS could be suitable for the LADM country profile for China too.

2. Recommendations for further research

As for the recommendations for further research, there are several aspects which need to in depth research:

- As for the analysis of existing structure, only one pilot has been adopted. In order to be more complete, more pilots can be studied in future. E.g. on organizational scenario's and also on workflows.
- And for the analysis of user requirements, the main focus is legal requirements. The next research could cover more data sources. E.g. questionnaire or interview could be arranged.
- Then, for the transformation to chosen classes, the rule for transformation need more studies.
- With regard to the scope, this thesis only focuses on the urban land and housing management in China. While the integration of rural and urban issues is a very hot topic, thus in future this country profile could cover the scope of rural land and housing management accordingly. In addition, according to the PL and Guarantee Law in China, the complete concept of real estate information could be extended with more entities, not just land and housing. Therefore, the integration of other entities, like forest, water etc., could be focus of the attention of further research.

3 The STDM is a specialisation of the LADM (C.H.J. Lemmen, 2010).

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ANNEXES

Annex 1: Transcriptions of Related Laws and Regulations

Land Administration Law of the People's Republic of China & Newest Land Administration Law of the People's Republic of China

In the living version of land administration law in China, these related articles have been collected as follows:

- ***Article 12*** *Whoever* ***changes in land tenure and the use purposes****, shall go through the* ***maintenance of land tenure****.*
- ***Article 46*** *… Owners or users of the land expropriated shall, within the time limit specified in the announcement, go through the* ***compensation registration for expropriated land*** *with the land administrative departments of the local people's governments on the strength of the* ***land certificate****.*
- ***Article 47*** *In expropriating land,* ***compensation*** *shall be made according to the* ***original purposes of the land expropriated****.*

  Compensation fees *for land expropriated include* ***land compensation fees****, resettlement fees and* ***compensation for appendices*** *to or green crops on the land…*
- ***Article 55*** *Construction units that have obtained State-owned land by paid leasing can use the land only after paying the* ***land use right leasing fees and other fees and expenses*** *according to the standards and ways prescribed by the State Council.*
- ***Article 57*** *… Whoever* ***uses the land temporarily*** *shall use the land according to the purposes agreed upon in the contract for the temporary use of land and* ***shall not build permanent structures****.*

  The ***term for the temporary use of land*** *shall not usually exceed two years.*

In 2009, the latest draft version of land administration law, which was delivered by the MLR, also proposed several new articles.

- ***Article 19*** *The right to use construction land may be* ***created separately on the surface of or above or under the land****. The newly-established one may not injure the usufructuary right that has already been established …*
- ***Article 28*** *In case rights of the land were registered according to laws, the building, fixtures and affiliated facilities thereof on such land shall* ***be registered at the same time****.*
- ***Article 29*** *…Land registration shall be organized and implemented* ***in county administrative areas*** *…*
- ***Article 31*** *the State shall create a* ***unified land registration system****, all kinds of land registers should be submitted and joint together according to laws, and land registration information may* ***be open to inquiry****.*
- ***Article 93*** *…The* ***methods of paid use of construction land include****: remising, leasing, using as equity contribution or investment.*
- ***Article 97*** *… In case the alienating and leasing of rights to use construction land, the* ***term of rights*** *shall be confirmed according to use purposes as follows:*
  - *Alienating: residential land (70 years), other lands (50 years)*
  - *Leasing: not exceeding 15 years*
  - *Using as equity contribution or investment: referring to the Alienating mode*
  - *…*
- ***Article 99*** *the State practices the* ***evaluation and declaration system of land price****. The government shall regularly formulate and publish the standard land price, nominal land price, minimum price, etc.*

  In case the transfer of rights to use construction land, shall truthfully declare the transaction price…

Regulations on the Implementation of the Land Administration Law of the People's Republic of China

- ***Article 6*** *Whoever* ***changes in land ownership or use right*** *according to laws, and the transfer of land use right which is caused by the* ***transfer of such appendices*** *as ground constructions and structures, must file an application for the change in land registration with the competent department of land administration of people's government above the county level of the*

locality wherein the land is located, then the original land registration organ shall proceed the ***maintenance of land ownership or use right****. The alternation of land ownership or use right would take effect as of the date of maintenance.*

Whoever ***changes in land use purposes*** *according to laws, must be on the strength of approval documents, and file an application for the change in maintenance with the competent department of land administration of people's government above the county level of the locality wherein the land is located, and the original land registration organ shall proceed the* ***maintenance of land use purposes*** *according to laws.*

Measures for Land Registration

- ***Article 9*** *In case the applicant files an application for land registration, must submit the following materials accordingly:* ***Land registration application form; identification materials of the applicant; certificates of land tenure; cadastral survey, parcel map and boundary coordinates; certificates of appendices rights; tax paid proof and tax reliefs proof****, and other materials.*

- ***Article 15*** *Land register book is the basis of the land rights and its contents. The following items should be included:* ***name and domicile of land subjects concerned; the nature of land rights, type of land use right, acquired date and term, and alternations of land rights or contents; location, boundary, area, parcel id, use purpose and acquired price of land; the situation of its appendices****…*

- ***Article 40*** *Whoever* ***changes in land use right****, which is caused by the transfer, exchanging, and endowing of the buildings, fixtures and affiliated facilities thereof on such land according to laws, the party concerned must file an application for the* ***maintenance of land registration*** *on the strength of* ***original certificate of land use right, changed certificate of housing ownership and relevant documents about the alternation of land use right****…*

- ***Article 75*** *With affirmation of the provincial, autonomous regional or municipal people's governments, there should be* ***one department that is responsible for both land and housing registration*** *with the local government at or above the county level…*

Measures for Building Registration

- ***Article 8*** *For housing registration, it is necessary to follow the principle of* ***subject consistency for housing ownership and its appurtenant land use right****.*

- ***Article 30*** *In case the applicant files an application for initial housing registration of legal buildings, must submit the following materials:* ***housing registration application form; identification materials of the applicant; certificate of construction land use right; construction planning permit; document of as-built inspection of building; report of housing surveying and mapping****; and other materials.*

- ***Article 60*** *In case the applicant files an application for mortgage registration of under-construction project, must submit the following materials:* ***registration application form; identification materials of the applicant; mortgage contract; contract of master obligatory right; certificate of construction land use right or certificate of real estate right; construction planning permit;*** *and other materials.*

- ***Article 95*** *Certificates or documents of housing ownership shall be formulated in a unified form, procedure and identification system by the competent department of the State Council. A kind of* ***title certificate in a unified form*** *should be made and disseminated in a unified way by a department designated by a people's government above the county level for* ***unified administration of real estate****.....…*

Property Law of the People's Republic of China

Registration:

- ***Article 10****: …* ***A uniform registration system over realties*** *shall be practiced by the state. The scope, organ and measures of uniform registration shall be specified by the related laws and administrative regulations.*

- ***Article 135****: The* ***holder of the right to use construction land*** *has the right to possess, use and seek proceeds from the land owned by the state, and shall* ***be entitled to the construction of buildings****, fixtures and their auxiliary facilities by making use of such land.*

- ***Article 136*** *The* ***right to use construction land may be created separately on the surface of or above or under the land****. The newly-established one may not injure the usufructuary right that has already been established.*

- ***Article 246****: A local regulation may, before any law or administrative regulation prescribes the scope, organ and measures for* ***uniform registration of realties****, provide for related matters in accordance with the related provisions in the present Law.*

Mortgage:

- ***Article 182****: For mortgaging* ***building****, the* ***right to use construction land*** *within the area of this building shall* ***be mortgaged together****. When mortgaging the* ***right to use construction land****, all the* ***buildings*** *on such land shall* ***be mortgaged together****.*

- ***Article 183***: *As regards the right to use construction land of a township or village enterprise, mortgages may not be alone established thereon. Where the plant of a township and village enterprise is mortgaged, the right to use construction land within the area of such plant shall* ***be mortgaged together****.*
- ***Article 200***: *The buildings newly constructed on the land after the mortgage of the right to use construction land may not belong to the mortgaged properties. Such newly-constructed buildings can* ***be disposed of together*** *with the disposal of the aforesaid right to use construction land so as to realize the* ***mortgage right****; however, the mortgagee has no right to seek preferred payments from the money generated from the disposal of these newly-constructed buildings.*

Maintenance:

- ***Article 138***: *… In general, a contract on transfer of the right to use construction land shall contain the items as follows:* ***name and domicile of the parties concerned; boundary and area, etc. of the land; space to be covered by buildings, fixtures and affiliated facilities thereof; use purposes; use term; payment methods for allotment fees and other fees; and dispute settlement method.***
- ***Article 146***: *When alienating, exchanging, using as equity contribution, endowing, or mortgaging the right to use* ***construction land****,* ***the buildings, fixtures and affiliated facilities*** *thereof on such land shall* ***be disposed of at the same time.***
- ***Article 147***: *When alienating, exchanging, using as equity contribution, endowing, or mortgaging the buildings, fixtures and affiliated facilities thereof, the right to use construction land covered by the aforesaid buildings, fixtures and affiliated facilities thereof shall* ***be disposed of at the same time****.*

Others:

- ***Article 12*** *A registration organ shall perform the duties as follows:* ***to examine the ownership certificate and other necessary materials as provided by the applicant*** *…*
- ***Article 22*** ***Realty registration fees shall be charged on each piece,*** *and may not be charged on the basis of the size, volume or certain proportion of the realty's value. The concrete charging rates shall be formulated by the related departments in the State Council in collaboration with the competent pricing department.*
- ***Article 148*** ***Before the term*** *of the right to use construction land expires, where it is necessary to take back the land in advance by virtue of public interests,* ***compensations shall****, according to Article 42 of this Law,* ***be given to the houses and other realties on such land, and corresponding land transfer fees shall be returned back****.*

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- ***Article 32*** *In case of the transfer or mortgage of a real estate, the ownership of the building and the right to use the land occupied by the building are* ***transferred or mortgaged at the same time****.*
- ***Article 34*** *…The evaluation of price for a real estate should follow the principles of being just, fair and public in accordance with technical standards and evaluation procedures as stipulated by the State,* ***on the basis of the standard land price, nominal land price and appraised prices of various buildings, and referred to the local market prices****.*
- ***Article 45*** *An advanced sale of commodity housing must meet following conditions: (1) All the* ***land use right leasing fees*** *have been paid and the* ***certificate of land use right*** *has been obtained; (2) A* ***construction planning permit*** *has been held; (3)* ***Funds*** *put for construction of the houses for advanced sale have exceeded 25 percent of the total budgetary investment for the project and the construction schedule and date of completion of the project have been set; and (4) An advanced sale registration has been made with the housing administration of the people's government above the county level and* ***a permit of advanced sales of commodities house*** *has been obtained…*
- ***Article 48*** *The* ***title of a housing property plus the right to use the land occupied by the housing property*** *obtained lawfully may be designated as mortgage right…*
- ***Article 49*** *the* ***mortgage of real estate*** *shall be made upon the strength of the* ***certificates of land use right and housing ownership****.*
- ***Article 61*** *…Whoever transfers or changes a real estate, must file an application for the* ***registration of the change for housing ownership*** *with the housing administration department of the people's government above the county level, and the applicant shall file an application for the registration of the change for land use right on the strength of the* ***changed certificate of housing ownership****. After a verification made by the land administration department of the people's government at the same level, the people's government at the same level shall* ***renew or modify the certificate of land use right****…*
- ***Article 63*** *With affirmation of the provincial, autonomous regional or municipal people's governments, a kind of title certificate in* ***a unified form*** *should be made and disseminated in a unified way by a department designated by a people's government above the county level for unified administration of real estate in accordance with Article 61 of this law,* ***separately record***

the verification and change of the building title and the use right of the land on which the building is located in the real estate certificate.

Technical Specification of Real Estate Registration

- ***1.0.3*** *A number of principles that should be followed during real estate registration: the* ***institution of real estate registration*** *wherein the real estate located shall be responsible for the real estate registration, and practice the registration according to this specification; the* ***registrar*** *shall serve the verification issues during the registration procedure; the real estate registration shall be proceeded according to* ***applications****; to follow the* ***principle of subject consistency for housing ownership and its appurtenant land use right****; … the institution of real estate registration should provide the* ***service for information query of real estate registration*** *according to laws.*
- ***4.5.5*** ***Institutions for real estate registration should be merged****, and each register should be recorded on the corresponding register book…*
- ***5.1.3*** *Archives of real estate registration should* ***be managed in a unified way*** *by the institution for the management of real estate registration archives.*
- ***5.1.5*** *The institution for the management of real estate registration archives should provide the query tool of register archives and register book, and realize the functions of* ***bi-directional query, mutual query, combine query and fuzzy query****, etc., and also the authentication, etc.*

Guaranty Law of the People's Republic of China

- ***Article 34*** *The following properties may be mortgaged:* ***the housing and other appendices owned by the mortgagor****; the machine, transportation means and other property owned by the mortgagor;* ***the state-owned right to the use of land, housing and other appendices*** *which the mortgagor is entitled to dispose of according to laws; …*
- ***Article 36*** *In case the housing upon the state-owned land obtained according to laws is to be mortgaged, the right to use the state-owned land within the scope the housing occupied shall* ***be mortgaged at the same time****. In case the right to use the state-owned land obtained by way of transfer according to laws is mortgaged, the housing upon the foresaid state-owned land shall* ***be mortgaged at the same time****…*
- ***Article 42*** *The departments handling the gage registration are as follows: in case that the right to use land without fixtures upon the land is to be mortgaged, it shall be* ***the land administration departments*** *which upon verification issue certificates for the right to use land****;*** *in case that the urban real estates or the building of the township (town) or village enterprises such as a plant is to be mortgaged, it shall be the departments prescribed by* ***the local people's governments at and above the county level****; …*
- ***Article 55*** *After the signing of the urban real estate mortgage contract, the newly-built housing upon the land shall not belong to the gage. When the foresaid mortgaged real estate is needed to be auctioned,* ***the newly-built housing upon the land may be auctioned together with the gage****, but as for the amount from the auction, the mortgagee shall not be entitled to have priority in satisfying the claim out of proceeds.*

Annex 2: Normative Reference Material

No.	Title	Title No.	Issuing Organizations
1	Standards for Urban Cadastral Database	TD/T 1015-2007	MLR
2	Specifications for Cadastral Surveying and Mapping	CH 5002-94	MLR
3	Specifications for Data Classification and Codes of Fundamental Geographic Information	GB/T 13923-2006	MLR
4	Codes for the administrative divisions of the people's republic of China	GB/T 2260	MLR
5	Current Land Use Classification	GB/T 21010-2007	MLR
6	Technical Code for Real Estate Market Information System	CJJ/T 115-2007	MC
7	Specifications for House Surveying	GB/T 17986.1-2000	MC
8	Measures for Land Registration	Order of the Ministry of Land and Resources (No. 40)	MLR
9	Measures for Building Registration	Order of the Ministry of Construction (No. 168)	MC
10	Notice of Relevant Questions about the Registration	Chongqing Textual Trail	BLRH

	of Land and Housing in Chongqing BLRH	[2008] (No. 23)	

Annex 3: Attribute Structures of Spatial Features in Bureau of Land Resources and Housing in Chongqing Municipality (2010b)

- Attribute Structure of Control Point (CP) (Table Name: CLKZD)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		>0	M
2	Feature Code	YSDM	Int.	12			M
3	Name of CP	KZDMC	Char	50		Not Null	O
4	CP No.	KZDDH	Char	10		Not Null	O
5	Type of CP	KZDLX	Char	6			M
6	Rank of CP	KZDDJ	Char	6			M
7	Type of Markstone	BSLX	Char	1			M
8	Type of Mark	BZLX	Char	1			M
9	Status of CP	KZDZT	Char	100			O
10	Description of CP	DZJ	Varbin			Not Null	M
11	X(E)_XA80	X80	Float	10	3	≥0	C
12	Y(E)_XA80	Y80	Float	10	3	≥0	C
13	Z_XA80	Z80	Float	10	3	(-160,8850)	C
14	X(E)_BJ54	X54	Float	10	3	≥0	C
15	Y(E)_BJ54	Y54	Float	10	3	≥0	C
16	Z_BJ54	Z54	Float	10	3	(-160,8850)	C
17	X(E)_CQ	X54	Float	10	3	≥0	C
18	Y(E)_CQ	Y54	Float	10	3	≥0	C
19	Z_CQ	Z54	Float	10	3	(-160,8850)	C

Note 1: Constraint Condition: M (Mandatory), O(Optional), C(Condition will fill), hereafter inclusive.
Note 2: Status of CP refers to the current preservation situation of CP, which can be described as intact, partly damaged, completely damaged, etc.
Note 3: Varbin means that during the data exchange, the file linked to this field should be copied to the physical address of exchanged data, and meanwhile, the physical address should be changed too.
Note4: among the groups of No.11&12&13, No.14&15&16 and No.17&18&19, one of them is compulsory.

- Attribute Structure of Administrative Area (Table Name: XZQ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Code of Administrative Area	XZQDM	Char	12		See GB/T2260	M
4	Name of Administrative Area	XZQMC	Char	100		See GB/T2260	M
5	Control Area	KZMJ	Float	15	2	＞0	C
6	Calculated Area	JSMJ	Float	15	2	＞0	M

Note 1: Code and Name of Administrative Area consults the GB/T2260.
Note 2: Calculated Area refers to the area by using geodetic coordinates.

- Attribute Structure of Boundary of Administrative Area (Table Name: XZQJX)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition

1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Type of Boundary	JXLX	Int.	6			M
4	Property of Boundary	JXXZ	Int.	6			M
5	Description of Boundary	JXSM	Char	100		Not Null	O

- Attribute Structure of Contour Line (Table Name: DGX)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Type of Contour Line	DGXLX	Int.	6			M
4	Marked Elevation	BSGC	Int.	4		(-160,8850)	M

- Attribute Structure of Elevation Point with Notes (Table Name: GCZJD)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Marked Elevation	BSGC	Float	7	2	(-160,8850)	M

- Attribute Structure of Parcel (Table Name: ZD)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Cadastre No.	DJH	Int.	19		Not Null	M
4	Relative Location of Adjoining Parcels (RLAPs)	ZDSZ	Char	200		Not Null	M
5	Correspondence Address	TXDZ	Char	100		Not Null	M
6	Land Site	TDZL	Char	100		Not Null	M
7	Property of Land Right	QSXZ	Int.	2			M
8	Type of Land Use Right	SYQLX	Int.	2			M
9	Type of Land Use	TDYT	Char	4			M
10	Measured Area	SCMJ	Float	16	2	＞0	M
11	Certificated Area	FZMJ	Float	16	2	＞0	O
12	Floor Space Ratio	JZRJL	Float	4	2	＞0	O
13	Building Density	JZMD	Float	3	2	[0, 1]	O
14	Land Grade	TDJB	Int.	3			O
15	Declared Land Price	SBDJ	Float	15	2	＞0	O
16	Acquired Land Price	QDJG	Float	15	2	＞0	O
Note: Subject of Land Tenure, Mortgage Right and Easement will be described in following extended attribute tables. And identification code in these tables should be consistent.							

- Attribute Structure of Building Cadastre (Table Name: QJLZ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Building Cadastre No.	QJLZH	Int.	24		Not Null	M
4	Appurtenant Parcel	LSZD	Int.	20		Not Null	M
5	Housing No.	MPH	Char	20			O
6	Property of Land Right	QSXZ	Int.	2			O
7	Land Grade	YDDJ	Int.	3			O
8	Acquired Land Price	QDJG	Float	15	2	＞0	O
9	Land Tax	YDSF	Float	15	2	＞0	O
10	Subject of Land Use Right	YDSYQZ	Char	20			O
11	Land User	YDSYR	Char	20			O
12	Type of Land Use Right	TDSYQLX	Int.	2			M
13	Land Source Time	YDLYSJ	Date	10		YYYYMMDD	O
14	Type of Land Use	YDYT	Int.	4			O
15	Area of Land Use	YDMJ	Float	15	2	＞0	M
16	Relationship of RLAPs	SZGX	Char	200		Not Null	M
17	Building Site	LZZL	Char	100			O
18	Owner of Building	LZCQR	Char	50			O
19	Type of Building Ownership	LZCQLB	Int.	1			M
20	Source of Building Ownership	LZCQLY	Char	200			O
21	Number of Building Floors	LZZCS	Int.	3		Not Null	M
22	Building Structure	LZJG	Int.	1			M
23	Built Year	JCNF	Date	10		YYYYMMDD	O
24	Building Area	JZMJ	Float	15	2	＞0	M
25	Type of Building Use	LZYT	Int.	3			M
26	Ownership of Walls	QTGS	Char	200			O
27	Enclosure Notation of Building Ownership	LZCQFJSM	Char	200			O
28	Building Image Map	YXFZT	Varbin				C
29	Building Vector Map	SLFZT	Varbin				C

- Attribute Structure of Building (Table Name: FWLZ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Appurtenant Parcel	LSZD	Int.	19		Not Null	M
4	Number of Building	LZBH	Int.	24		Not Null	M
5	Name of Building Project	DTGCMC	Char	100			O
6	Building No.	ZH	Char	20			O

7	Site Address	ZLDZ	Char	100			O
8	Building Structure	LZJG	Int.	1			M
9	Total Floor	ZCS	Int.	3		Not Null	M
10	Ground Floor	DSCS	Int.	3		Not Null	M
11	Underground Floor	DXCS	Int.	3		Not Null	M
12	Building Area	JZMJ	Float	15	2	＞0	M
13	Underground Building Area	DXJZMJ	Float	15	2	＞0	M
14	Ground Floor Area	DSZDMJ	Float	15	2	＞0	M
15	Underground Floor Area	DXZDMJ	Float	15	2	＞0	M
16	Commencement Date	KGRQ	Date	10		YYYYMMDD	O
17	Completion Date	JGRQ	Date	10		YYYYMMDD	O
Note1: number of building refers to the number adopting the numbering system of this standard; While Building No. refers to the number in the management building; Note2: Total Floor refers to the physical floors of the building; Note3: the number of building in the table of Building Unit, Floor, and Room should be the same as the one in this table.							

- Attribute Structure of Building Unit (Table Name: FWDY)

No.	**Field Name**	**Field Code**	**Field Type**	**Field Length**	**Decimal Digit**	**Domain**	**Constraint Condition**
1	Identification Code	BSM	Int.	10		＞0	M
2	Number of Building	LZBH	Int.	24		Not Null	M
3	No. of Building Unit	DYH	Int.	2		Not Null	M
4	Total Set of Building Unit	DYFWZTS	Int.	10		≥0	M
5	Image Map of Building Unit	FWDYYXT	Varbin				O
6	Vector Map of Building Unit	FWDYSLT	Varbin				O
Note1: No. of building unit refers to the initial number of building unit;							

- Attribute Structure of Floor (Table Name: FWLC)

No.	**Field Name**	**Field Code**	**Field Type**	**Field Length**	**Decimal Digit**	**Domain**	**Constraint Condition**
1	Identification Code	BSM	Int.	10		＞0	M
2	Number of Building	LZBH	Int.	24		Not Null	M
3	Floor	LC	Int.	3		Not Null	M
4	Floor Note	BZLC	Char	10		Not Null	M
5	Total Set of Floor	LCFWZTS	Int.	4		＞0	M
6	Image Map of Floor	FCFHYXT	Varbin				C
7	Vector Map of Floor	FCFHSLT	Varbin				C
Note1: Floor labels physical floors, begins with the ground floor and numbers from the bottom; Note2: Floor Note refers to the note of physical floors, in general, refers to nominal floors; Note3: For No.6 and 7, both choose at least one.							

- Attribute Structure of Room (Table Name: FWHS)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Number of Building	LZBH	Int.	24		Not Null	M
3	Housing Cadastre No.	FJH	Int.	34		Not Null	M
4	Site	ZL	Char	100		Not Null	M
5	Building No.	ZH	Char	20			O
6	No. of Building Unit	DYH	Int.	10		Not Null	M
7	Floor	LC	Int.	10		Not Null	M
8	Room No.	FH	Char	20		Not Null	M
9	Layout of the Room	HX	Int.	1			M
10	Room Usage	HSYT	Int.	3			M
11	Property of Housing	FWXZ	Int.	1			M
12	Housing Structure	FWJG	Int.	1			M
13	Type of Property Right	CQLB	Int.	1			M
14	Building Area	JZMJ	Float	15	2	＞0	M
15	Room Building Area	TNJZMJ	Float	15	2	＞0	M
16	Built Date	JCSJ	Date	10		YYYYMMDD	O
17	Image Map of Room	FHYXT	Varbin				C
18	Vector Map of Room	FHSLT	Varbin				C
Note1: Housing Cadastre No. consults the encoding rule of this standard; Note2: No. of building unit refers to the No. of building unit which the room placed; Room No. refers to the No. adopted in the practical management. Note3: For the extended attribute tables of subject, mortgage, easement and preliminary notice, the identification code, housing cadastre No. should keep exactly the same.							

- Attribute Structure of Subject of Land Tenure (Table Name: ZD_QLR)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Cadastre No.	DJH	Int.	19		Not Null	M
3	Real Estate Certificate No.	TDZH	Char	50		Not Null	O
4	Expiration Date	ZZRQ	Date	10		YYYYMMDD	M
5	Name of Subject of Land Tenure (SoLT)	QLRMC	Char	100		Not Null	M
6	Certification Type of SoLT	QLRZJLX	Int.	1			M
7	Certification No. of SoLT	QLRZJH	Char	20		Not Null	M
8	Name of Legal Representative(LR)	FRDBXM	Char	50		Not Null	M
9	Certification Type of LR	FRDBZJLX	Char	1			M
10	Certification No. of LR	FRDBZJH	Char	30		Not Null	M
11	Identity Certificate (IC) of LR	FRDBSFZMS	Varbin			Not Null	M
12	Phone No. of LR	FRDBDHHM	Char	15		Not Null	O
13	Agent Name	DLRXM	Char	50		Not Null	O
14	Certification Type of Agent	DLRZJLX	Char	1			O
15	Certification No. of Agent	DLRZJH	Char	20		Not Null	O

16	IC of Agent	DLRSFZMS	Varbin			Not Null	O
17	Phone No. of Agent	DLRDHHM	Char	15		Not Null	O

- Attribute Structure of Housing Owner (Table Name: FW_SYQR)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Housing Cadastre No.	FJH	Char	34		Not Null	C
3	Building No.	LZBH	Int.	24		Not Null	C
4	Appurtenant Parcel	LSZD	Int.	19		Not Null	M
5	Real Estate Certificate No.	FDCQZH	Char	50		Not Null	O
6	Type of Property Right	CQLB	Int.	1		Not Null	M
7	Placed Layer	SZCS	Int.	3			M
8	Building Site	FWZL	Char	100		Not Null	M
9	Building Area	JZMJ	Float	15	2	＞0	M
10	Room Area	TNMJ	Float	15	2	＞0	O
11	Subject of Housing Ownership (SoHO)	QLR	Char	100		Not Null	M
12	Certification Type of SoHO	QLRZJLX	Int.	1			M
13	Certification No. of SoHO	QLRZJH	Char	20		Not Null	M
14	Currency of Real Estate Value	FDCJZBZ	Char	20		Not Null	O
15	Real Estate Value	FDCJZ	Number	12	2	Not Null	O
16	Value Converted into Renminbi	ZHRMBJZ	Number	12	2	Not Null	O
17	Share of Housing	ZYFE	Float	4		2	O
18	Registration Date	DJSJ	Date	20		YYYYMMDD mi:hh:ss	O
19	Approval Institution	HZDJJG	Char	100		Not Null	M
20	Approval Date	HZSJ	Date	20		YYYYMMDD mi:hh:ss	O
Note1: If the registration unit is building, the identification code should be the identification code of building; If the registration unit is room, choose one from No. 2 and 3 in this table; Note2: If there are a number of property subject in one building, then each one should be one record in the registration.							

- Extended Attribute Structure of Land and Housing Mortgage (Table Name: TDFW_DYQ1)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Cadastre No.	DJH	Int.	19			C
3	Housing Cadastre No.	FJH	Int.	34			C
4	Building No.	LZBH	Int.	24			C
5	Certificate No. of Mortgage	DYQZH	Char	20		Not Null	M
6	Type of Mortgage	DYLB	Char	50		Not Null	M
7	Mortgagee	DYQR	Char	20		Not Null	M

8	Certificate Type of Mortgagee	DYQRZJLX	Int.	1			M
9	Certificate No. of Mortgagee	DYQRZJH	Char	20		Not Null	M
10	Mortgagor	DYR	Char	20		Not Null	M
12	Certificate Type of Mortgagor	DYRZJLX	Int.	1			M
13	Certificate No. of Mortgagor	DYRZJH	Char	20		Not Null	M
14	Time Limit for Debt Performance	ZWLXQX	Char	100		Not Null	M
15	Mortgage Currency	DYBZ	Char	20		Not Null	M
16	Mortgage Value	DYJZ	Number	12	2	Not Null	M
17	Commencement Date of Mortgage	DYKSSJ	Date	20		YYYYMMDD	M
18	Expiration Date of Mortgage	DYZZSJ	Date	20		YYYYMMDD	M
19	Mortgage Area	DYMJ	Float	15	2	＞0	O
20	Mortgage Value Converted into Renminbi	DYRMBJZ	Number	12	2	Not Null	M
21	Registration Date	DJSJ	Date	20		YYYYMMDD mi:hh:ss	O
22	Approval Institution	HZDJJG	Char	100		Not Null	M
23	Approval Date	HZSJ	Date	20		YYYYMMDD mi:hh:ss	O
Note1: the mortgage in this table refers to the mortgage of land use right; Note2: Fill in the table in the smallest unit of housing registration, and each unit will be one record.							

- Extended Attribute Structure of Land and Housing Easement (Table Name: TDFW_DYQ1)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Cadastre No.	DJH	Int.	19		Not Null	O
3	Housing Cadastre No.	FJH	Int.	34		Not Null	O
4	Type of Easement	DYQZL	Char	30		Not Null	M
5	Housing Cadastre No. of Dominant Tenement	XYDFJH	Int.	34		Not Null	O
6	Housing Cadastre No. of Servient Tenement	GYDFJH	Int.	34		Not Null	O
7	Building Site of Easement	DYQFWZL	Char	500		Not Null	M
8	Content of Easement	DYQZYNR	Char	2000		Not Null	M
9	Commencement Date of Easement	DYQQZRQ	Date	20		YYYYMMDD	M
10	Expiration Date of Easement	DYQZZRQ	Date	20		YYYYMMDD	M
11	Registration Date	DJSJ	Date	20		YYYYMMDD mi:hh:ss	O

12	Approval Institution	HZDJJG	Char	100		Not Null	M
13	Approval Date	HZSJ	Date	20		YYYYMMDD mi:hh:ss	O

- Extended Attribute Structure of Preliminary Notice (Table Name: FW_YGDJ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Housing Cadastre No.	FJH	Int.	34		Not Null	M
3	Subject of Preliminary Notice	YGDJQLR	Char	20		Not Null	M
4	Obligor of Preliminary Notice	YGDJYWR	Char	20		Not Null	M
5	Building Site	FWZL	Char	500		Not Null	M
6	Business Type of Preliminary Notice	YGDJYWZL	Char	30		Not Null	M
7	Identification No. of Preliminary Notice	YGDJZMH	Char	50		Not Null	M
8	Approval Date	HZSJ	Date	20		YYYYMMDD mi:hh:ss	O

- Attribute Structure of Parcel Boundary Line (Table Name: ZDJZX)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Length of Parcel Boundary Line	JZXCD	Float	15	2	＞0	M
4	Property of Parcel Boundary Line	JXXZ	Int.	6			M
5	Type of Parcel Boundary Line	JZXLB	Int.	1			M
6	Location of Parcel Boundary Line	JZXWZ	Int.	1			M
7	Agreement No. of Parcel Boundary Line	QSJXXYSBH	Char	30		Not Null	C
8	Agreement of Parcel Boundary Line	QSJXXYS	Varbin			Not Null	C
9	Reason Book No. of Parcel Boundary Line Dispute	QSZYYYSBH	Char	30		Not Null	C
10	Reason Book of Parcel Boundary Line Dispute	QSZYYYS	Varbin			Not Null	C
Note: among the groups of No.7&8 and No.9&10, one of them is compulsory.							

- Attribute Structure of Parcel Boundary Point (Table Name: ZDJZD)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M

3	Parcel Boundary Point No.	JZDH	Char	10		Not Null	M
4	Type of LandMark	JBLX	Int.	1			M
5	Type of Parcel Boundary Point	JZDLX	Int.	1			M

- Attribute Structure of Building Boundary Line (Table Name: LZQJX)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		>0	M
2	Feature Code	YSDM	Int.	12			M
3	Length of Building Boundary Line	QJXCD	Float	15	2	>0	M
4	Property of Building Boundary Line	QJXXZ	Int.	6			M

- Attribute Structure of Building Boundary Point (Table Name: LZQJD)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		>0	M
2	Feature Code	YSDM	Int.	12			M
3	Building Boundary Point No.	QJDH	Char	15		Not Null	M

- Attribute Structure of Patch of Land Class (Table Name: DLTB)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		>0	M
2	Feature Code	YSDM	Int.	12			M
3	Pre-No. of Patch	TBYBH	Char	8		Not Null	O
4	Patch No.	TBBH	Char	8		Not Null	M
5	Land Class No.	DLBM	Char	4		See Note 1	M
6	Land Class Name	DLMC	Char	60		See Note 1	M
7	Property of Land Right	QSXZ	Int.	2			M
8	Code of Property Unit	QSDWDM	Char	19		See Note 3	M
9	Name of Property Unit	QSDWMC	Char	60		Not Null	M
10	Code of Location Unit	ZLDWDM	Char	19		See Note 3	M
11	Name of Location Unit	ZLDWMC	Char	60		Not Null	M
12	Type of Cultivated Land	GDLX	Char	2		See Note 7	O
13	Type of Discard Land	KCLX	Char	2		See Note 8	O
14	Code of Discard Land Class	KCDLBM	Char	4		See Note 1	O
15	Coefficient of Discard Land Class	TKXS	Float	5	2	>0	O
16	Patch Area	TBMJ	Float	15	2	>0	M
17	Area of Linear Feature	XZDWMJ	Float	15	2	≥0	O

18	Area of Discard Land Class	TKMJ	Float	15	2	≥0	O
19	Land Class Area of Patch	TBDLMJ	Float	15	2	≥0	M
20	Approval No.	PZWH	Char	50		Not Null	O
21	Record No. of Alternation	BGJLH	Char	20		Not Null	O
22	Alternation Date	BGRQ	Date	8		YYYYMMDD	O

Note1: Code and Name of Land Class consults 'Current Land Use Classification' GB/T21010-2007;
Note2: Patch is numbering in blocks (villages); The number of alternative patch will be the next number of the largest patch number; Patch should cover the whole block (village); The boundary line of patch should not cross the boundary line of parcel;
Note 3: Block is equivalent to the administrative village, parcel is equal to the villager group;
Note 4: Code of location unit refers to the code of the patch's actual location;
Note 5: Patch area is area of all the classes within the polygon of patch, which has been verified.
Note 6: Area of linear feature refers to the total area of all linear features within the patch;
Note 7: Area of discard land class: when the type is 'TK', the area refers to the discard field ridge area; While the type is not 'TK', the area refers to the discard other areas;
Note 8: Area of patch land class = area of patch – area of discard land class – area of linear feature;
Note 9: Permit No. means the no. of an approved constructive land.

- Attribute Structure of Linear Feature (Table Name: XZDW)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Land Class No.	DLBM	Char	4		See Note 1	M
4	Land Class Name	DLMC	Char	60		See Note 1	M
5	Pre-No. of Linear Feature	XZDWYBH	Char	8		Not Null	O
6	No. of Linear Feature	XZDWBH	Char	8		Not Null	M
7	Length	CD	Float	15	1	＞0	M
8	Width	KD	Float	15	1	＞0	M
9	Area of Linear Feature	XZDWMJ	Float	15	2	＞0	M
10	Name of Linear Feature	XZDWMC	Char	60		Not Null	O
11	Code of Property Unit (1)	QSDWDM1	Char	19		See Note 3	M
12	Name of Property Unit (1)	QSDWMC1	Char	60		Not Null	M
13	Code of Property Unit (2)	QSDWDM2	Char	19		See Note 3	O
14	Name of Property Unit (2)	QSDWMC2	Char	60		Not Null	O
15	No. of Discard Patch (1)	KCTBBH1	Char	8		Not Null	M
16	Code of Discard Property Patch Unit (1)	KCTBDWDM1	Char	19		See Note 3	M
17	No. of Discard Patch (2)	KCTBBH2	Char	8		Not Null	O
18	Code of Discard Property Patch Unit (2)	KCTBDWDM2	Char	19		See Note 3	O
19	Property of Land Right	QSXZ	Int.	2			M
20	Discard Ratio	KCBL	Float	5	1	(0.5, 1)	M
21	Record No. of Alternation	BGJLH	Char	20		＞0	O
22	Alternation Date	BGRQ	Date	8		YYYYM	O

						MDD	

Note1: Linear Feature refers to the geographical name of this linear feature;
Note2: If the linear feature belongs to the unit of both sides, then the code of property unit (2) will be compulsory;
Note3: When it is necessary to discard the area from two patches, then No.17 will be compulsory, and the discard ratio will be 0.5; otherwise No.17 will be blank, the ratio will be 1.

- Attribute Structure of Land Class Boundary (Table Name: DLJX)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Type of Land Class Boundary	DLJXLX	Int.	2			M

- Attribute Structure of Annotation (Table Name: ZJ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Annotation Content	ZJNR	Char	60		Not Null	M
4	Font	ZT	Char	4		Not Null	M
5	Color	YC	Char	12		Not Null	M
6	Poundage	BS	Int.	4		＞0	O
7	Form	XZ	Char	1		Not Null	O
8	Underline	XHX	Char	1		Not Null	O
9	Width	KD	Float	15	1	＞0	O
10	Height	GD	Float	15	1	＞0	O
11	Space	JG	Float	6	2	＞0	O
12	X Coordinate of Left Bottom of Annotation Point	ZJDZXJXZB	Float	15	3	＞0	M
13	Y Coordinate of Left Bottom of Annotation Point	ZJDZXJYZB	Float	15	3	＞0	M
14	Orientation of Annotation	ZJFX	Float	10	6	[0, 2Π）	M

- Attribute Structure of Raster Data (Table Name: SGSJ)

No.	Field Name	Field Code	Field Type	Field Length	Decimal Digit	Domain	Constraint Condition
1	Identification Code	BSM	Int.	10		＞0	M
2	Feature Code	YSDM	Int.	12			M
3	Data File Name	SJWJM	Varbin			Not Null	M
4	Header Name	TWJM	Varbin			Not Null	O
5	Metadata File Name	YSJWJM	Varbin			Not Null	M

Annex 4: Required LADM Classes and Code Lists

No.		Required Classes & Attributes	LADM Classes	Attributes & Code Lists
1	1-1	Land use right and its appurtenant housing ownership	CN_RRR	• description: the description of the RRR • rID: the identifier of the RRR, which should be corresponding to the identifier of the source document
			CN_PropertyRight	• type: CN_RightType (land use right/condominium ownership/co-ownership of common elements)
	1-2	Registration date	CN_Source	• recordation: the date of registration of the source by the department
	1-3	Located county	CN_AdministrativeArea	• aaID: the identifier of administrative area • name: the name of administrative area • hierarchyLevel: the county level of administrative subdivision is 4 (county-provincial-municipal-county)
	1-4	Land Legal documents (Application form, identification materials of the applicant, certificates of land use right and housing ownership, alternation of land tenure)	CN_Source	• acceptance: the date of force of law of the source • lifeSpanStamp: the moment for the change of sources • recordation: the date of registration of the source by the department • sID: the identifier of the source • submission: the date of submission of the source by a party • availabilityStatus: CN_AvailabilityStatusType (complete/incomplete/destroyed) • type: CN_SourceType (administrative source) • source: CN_ResponsibleParty
			CN_AdministrativeSource	• text: the content of the document • type: CN_AdministrativeSourceType (application form/identification material/certificate of land use right or housing ownership/alternation document)
	1-5	Survey documents (cadastral & housing survey, parcel map, boundary coordinates)	CN_SpatialSource	• type: CN_SpatialSourceType (cadastral survey/housing survey/parcel map/boundary coordinate) • measurements: OM_Observation • procedures: OM_Process
	1-6	Tax paid proof and tax reliefs proof	CN_Source	the same as **1-4**
			CN_AdministrativeSource	• type: CN_AdministrativeSourceType (tax paid proof/tax reliefs proof)
	1-7	Name and address of land subject	CN_Party	• name: land user name • role: CN_PartyRoleType (land user) • type: CN_PartyType (natural/nonNatural person)
			VersionedObject	• source: CN_ResponsibleParty (address)

	1-8	Nature, type, acquired date, term of land tenure	CN_RRR	• beginTerm: the acquired date of the land use right • endTerm: the end date of the term of land use right
			CN_PropertyRight	the same as **1-1**
	1-9	Changes in land tenure and content	It is noteworthy that the changes in land tenure include the changes of responsible party or term of land tenure.	
			CN_RRR	the same as **1-8**
			CN_PropertyRight	the same as **1-1**
			CN_Ownership	• type: CN_OwnershipType (state-owned/collective)
			CN_Party	the same as **1-7**
			For the changes in land content, it contains the changes of use purpose, merge and subdivision.	
			CN_Parcel	• supID: the identifier of the parcel based spatial unit
			CN_CommonSpatialUnit	• area: CN_Area (the area of different types for the parcel based spatial unit (certificated)) • landUsage: CN_LandUsage (the usage of parcel based spatial unit)
	1-10	Location, boundary, area, identification, use purpose, acquired price of land	CN_Parcel	• supID: the identifier of the parcel based spatial unit • acquiredPrice: the acquired price of the parcel based spatial unit
			CN_CommonSpatialUnit	• location: the location of the parcel based spatial unit • area: the same as **1-9** • landUsage: the same as **1-9**
			CN_BoundaryFaceString	• type: CN_BoundaryFaceStringType (the type of boundary line) • boundary: CN_BoundaryLineType (the type of parcel boundary line) • nature: CN_BoundaryLineNature (the nature of the boundary line)
	1-11	Housing legal documents (application form, identification materials of the applicant, Construction planning permit, document of as-built inspection of building)	CN_Source	the same as **1-4**
			CN_AdministrativeSource	• type: CN_AdministrativeSourceType (application form/identification material/Construction planning permit/document of as-built inspection of building)
2	**2-1**	Changes in land tenure (includes land ownership or use right)	The same as the tenure part of **1-9**	
	2-2	Changes in use purposes	CN_CommonSpatialUnit	• landUsage: the same as **1-9**
	2-3	Changes in housing ownership	CN_RRR	the same as **1-8**
			CN_PropertyRight	the same as **1-1**
			CN_Party	the same as **1-7**
	2-4	Responsible departments (original land registration organ, housing administration department, land administration department)	CN_Party	• name: name of responsible department • role: CN_PartyRoleType (land administration department/housing administration department)

			• type: CN_PartyType (nonNatural person)
2-5	Legal documents about alternation (Application form, approval documents,)	CN_Source	the same as **1-4**
		CN_AdministrativeSource	• type: CN_AdministrativeSourceType (application form/approval documents)
2-6	Certificates of land use right and housing ownership (original & new)	CN_Source	• availabilityStatus: CN_AvailabilityStatusType (original) • the remain part is the same as 1-4
		CN_AdministrativeSource	• type: CN_AdministrativeSourceType (certificate of land use right/certificate of housing ownership)

3	**3-1**	Legal documents (Application form (housing mortgage registration), identification materials of the applicant, mortgage contract, Master obligatory right contract, Certificate of land use right and housing ownership, Construction planning permit)	CN_Source	the same as **1-4**
			CN_AdministrativeSource	• type: CN_AdministrativeSourceType (application form/identification materials/mortgage contract/Master obligatory right contract/Certificate of land use right and housing ownership/Construction planning permit)
	3-2	Built date	CN_Housing	• commence: the commence date of the construction project (e.g. according to the construction schedule) • built: the built date of the construction project (e.g. according to the construction schedule)
	3-3	Mortgage date, loan, gage, priority	CN_RRR	the same as **1-8**
			CN_Restriction	• partyRequired: 1 • type: mortgage
			CN_Mortgage	• amount: the amount loan of the mortgage • interestRate: the interest rate of the mortgage • ranking: the priority of mortgages applied to the same parcel • type: CN_MortgageType (land and housing mortgage/maximum mortgage/mortgage of under-construction project)
	3-4	Name of mortgagor and mortgagee	CN_Party	• name: name of mortgagor/mortgagee • role: CN_PartyRoleType (mortgagor/mortgagee) • type: CN_PartyType (natural/nonNatural person)
	3-5	Responsible departments (land administration department, housing administration department)	CN_Party	the same as **2-4**
4	**4-1**	Subject of land use right	CN_Party	• name: name of land user (housing owner) • role: CN_PartyRoleType (land user) • type: CN_PartyType (group/natural/nonNatural person)
			CN_GroupParty	• type: CN_GroupPartyType (parcel obligee (shared land use right))
			CN_PartyMember	• share: Fraction
	4-2	Subject of housing ownership	CN_Party	• name: name of housing owner • role: CN_PartyRoleType (housing owner) • type: CN_PartyType (natural/nonNatural person)
5	**5-1**	Submission date	CN_Source	• submission: the date of submission of the source by a party
	5-2	Responsible department	CN_Party	the same as **2-4**
	5-3	Real estate registration identification	CN_RRR	• rID: the identifier of the real estate registration
	5-4	Located administrative division	CN_AdministrativeArea	the same as **1-3**

	5-5	Certificate of real estate	CN_Source	the same as **1-4**
			CN_AdministrativeSource	• type: CN_AdministrativeSourceType (certificate of real estate)
	5-6	Verification and changes in the housing ownership and land use right	CN_Source	the same as **1-4**
			CN_AdministrativeSource	• approval: the approval date for the responsible department • The remain part is the same as 1-4 • For the changes in housing ownership and land use right, it is the same as **1-9**
	5-7	Name of Registrar	CN_Party	• name: name of registrar • role: CN_PartyRoleType (government official) • type: CN_PartyType (natural/nonNatural person)
	5-8	Record identification on the register book	CN_RRR	• rID: the identifier of real estate registration, and it should be consistent with the record on the register book
6	**6-1**	Piece number of real estate object	CN_BAUnit	• piece: the piece number of real estate object
7	**7-1**	Legal documents (Certificates of land use right and housing ownership, other materials provided by the applicant)	CN_Source	the same as **1-4**
	7-2	Name of registrar	CN_Party	the same as **5-7**
8	**8-1**	Right type (e.g. temporary land use right)	CN_RRR	the same as **1-1**
			CN_PropertyRight	• type: CN_RightType (temporary land use right)
	8-2	Term of land use right (e.g. temporary land use right: ≤ 2 years, commencement date and expiry date)	CN_RRR	the same as **1-8** Note: there should be an constraint to limit the term for temporary land use right)
	8-3	Payment to use of construction land	CN_Parcel	• acquiredPrice: the acquired price of the parcel based spatial unit
	8-4	Space right to land use (surface, above, or under the land)	CN_PropertyRight	• type: CN_RightType (land use right/housing ownership)
			CN_CommonSpatialUnit	• type: CN_SurfaceRelationType(above the surface/on the surface/under the surface)
	8-5	Subject of land use right	CN_Party	the same as **1-7**
	8-6	Restriction to land use right	CN_RRR	• description: the holder of land use right has the right to possess, use and seek proceeds from the land
			CN_PropertyRight	the same as **1-1**
9	**9-1**	Land use right leasing fee	CN_Parcel	the same as **8-3**
	9-2	Other fees and expresses	CN_Parcel	• landTax: the required tax fee of the parcel based spatial unit
	9-3	Term of rights to use construction land (	CN_RRR	the same as **1-8**

		commencement date, expiry date)		
	9-4	Disposal method	CN_PropertyRight	• disposal: alienating/exchanging/using as equity contribution/endowing • the remain part is the same as **1-1**
	9-5	Name, address of land subject	CN_Party	the same as **1-7**
	9-6	Boundary, area of the land	CN_CommonSpatialUnit	• area: CN_Area (the area of the parcel based spatial unit)
			CN_BoundaryFaceString	the same as **1-10**
	9-7	Covered space of appendices	CN_Housing	• volume: the volume value of the covered space of appendices
	9-8	Use purpose	CN_CommonSpatialUnit	• landUsage: CN_LandUsage (the usage of the parcel based spatial unit)
	9-9	Allotment fees and other fees	CN_Parcel	• acquiredPrice: the acquired price of the parcel based spatial unit • landTax: the required tax fee of the parcel based spatial unit
	9-10	Disposal date of land use right	CN_PropertyRight	• type: CN_RightType (land use right) • disposal: alienating/exchanging/using as equity contribution/endowing
			CN_Source	• recordation: Disposal time is just the effective time of registration, so here we will use registration time instead. Note: the disposal time of land use right should be equal to that of housing ownership.
	9-11	Disposal date of housing ownership		
			CN_PropertyRight	• type: CN_RightType (housing ownership) • disposal: the same as **9-10**
10	**10-1**	Subject of expropriated land	CN_Party	• name: the name of collective land owner/land user name • role: CN_PartyRoleType (collective land owner/land user) • type: CN_PartyType (nonNatural person)
	10-2	Time limit for the announcement	CN_RRR	• beginTerm: the acquired time of RRR
			CN_Source	• recordation: the effective time of registration Note: there should be a constraint to limit time span between acquired time and effective time.
	10-3	Compensation registration time for expropriated land	CN_Source	• recordation: the effective time of registration
			CN_Ownership	the same as **1-9**
			CN_Level	• register: CN_RegisterType (compensation registration)
	10-4	Responsible department	CN_Party	the same as **2-4**
	10-5	Certificate of land use right	CN_AdministrativeSource	• type: CN_AdministrativeSourceType (certificate of land use right)
	10-6	Use purpose (original & changed)	CN_CommonSpatialUnit	• landUsage: the same as **1-9**
	10-7	Compensation fee (land, and appendices)	CN_Parcel	• compensationFees: the compensation of the parcel based spatial unit Note: as for the compensation fee, it is the hottest topic in China. And the standard of

				compensation fee is still not known. Therefore, this research will only give a general concern on such topic.
	10-8	Term of expropriated land use right	CN_RRR	• term: the term of land use right
			CN_PropertyRight	• type: CN_RightType (land use right)
	10-9	Expropriated date	CN_RRR	• beginTerm: the expropriated date of land use right
			CN_PropertyRight	the same as **10-8**
	10-10	Land transfer fee	CN_Parcel	• acquiredPrice: the acquired price of the parcel based spatial unit
	10-11	Purpose of public interest	CN_Parcel	• purposeExpropriated: the purpose of public interest for the expropriated land
11	**11-1**	Standard land price	CN_Parcel	• standardLandPrice: the standard land price of parcel
	11-2	Nominal land price	CN_Parcel	• nominalLandPrice: the nominal land price of the parcel
	11-3	Replacement price	CN_Housing	• replacementPrice: the replacement price of the housing unit
12	**12-1**	Land use right leasing fee	CN_Parcel	the same as **10-10**
	12-2	Certificate of land use right	CN_AdministrativeSource	• type: CN_AdministrativeSourceType (certificate of land use right)
	12-3	Construction project planning permit	CN_AdministrativeSource	• type: CN_AdministrativeSourceType (Construction project planning permit)
	12-4	Funds put for construction, total budgetary investment (and per cent)	CN_PreRight	• type: CN_PreRightType (preliminary notice of advanced-purchased commercial housing/preliminary notice of setting mortgage on advanced-purchased commercial housing/preliminary notice of housing ownership maintenance/preliminary notice of housing ownership mortgage) • funds: the funds put for construction • investment: the total budgetary investment • percent: the percent for the total budgetary investment
	12-5	Construction schedule	CN_AdministrativeSource	• type: CN_AdministrativeSourceType (Construction schedule)
	12-6	Date of completion of the project	CN_PreRight	• completion: the completion date of the construction project
	12-7	Permit of advanced sale of commodity houses	CN_AdministrativeSource	• type: CN_AdministrativeSourceType (permit of advanced sale)
	12-8	Legal documents for preliminary notice (application form, identification materials of the applicant, permit of advanced sale)	CN_PreRight	• type: CN_PreRightType (the same as **12-4**)
			CN_AdministrativeSource	• type: CN_AdministrativeSourceType (application form/identification materials/permit of advanced sale)
	12-9	Advanced seller, advanced buyer	CN_Party	• name: name of obligee/obligor of preliminary notice • role: CN_PartyRoleType (obligee/obligor of preliminary notice) • type: CN_PartyType (natural/nonNatural person)
	12-10	Department, term of preliminary notice	CN_Party	the same as **2-4**

			CN_RRR	• term: the term for preliminary notice
13	**13-1**	Submission date	CN_Source	• submission: the same as **1-4**
	13-2	Name and address of land subject	CN_Party	the same as **1-7**
	13-3	Nature, type, acquired date, term of land tenure	CN_RRR	the same as **1-8**
			CN_PropertyRight	• type: CN_RightType (land use right)
	13-4	Changes in land tenure and content	the same as **1-9**	
	13-5	Location, boundary, area, identification, use purpose, acquired price of land	the same as **1-10**	
	13-6	Responsible department of register management	CN_Party	the same as **2-4**
	13-7	Identification for query	CN_ BAUnit	• bauID: the identifier of the basic administrative unit