Application and validation the Land Administration Domain Model in a real life situation (A case study in Indonesia)

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By

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Abstract

Keywords: Validation, LADM, Indonesia, Adat

The decentralization issue for the land administration system in Indonesia that is ruled by law number 32/2004 can lead to a variation in land administration system applications. The law stipulates that land administration shall be carried out by local government at district level. Concerning the huge number of districts/municipalities in Indonesia, standardization on land administration system is urged to be done to be able to support the development of a National Land Information System (NLIS). The need of National Land Information System (NLIS) is tangible because of economic development and also because of environmental protection which is not ceased at the border of districts/municipals.

Development of NLIS with a variation of subsystems can be achieved through service interoperability or data model standardization. The second is selected because it is expected to support in reduction of complexity and it is expected to reduce the costs of system development. Some data models on land administration domain have been published by several software vendors and countries. The Land Administration Domain Model (LADM) is selected as national standard model due to its completeness, the possibility to extend it, and the number of parties that are involved in its development.

Before applying LADM, validation is fundamental process to assess validity of this model. A first step in validation is collecting user requirements. The user requirements are verified against the LADM conceptual model. If the conceptual model can not satisfy user requirements it is likely that the model is unsuitable for a particular country. If the model satisfies the user requirements, further validation need to be done to assess validity of model again specific tenure systems and functionality of model to cope actual issues related to land administration system. Most of the user requirements that are collected during fieldwork are accommodated in LADM. However, some adaptation may be needed to accommodate the localities. For validation purposes, the methods of face validity and comparison with similar simulation model are used. Face validity is obtained by demonstration of model to proof credibility of work. For demonstration purpose, a prototype was built using free and open source software. The prototype includes all LADM packages. Similar simulation model is taken from an existing data model created within data entry project in Jakarta. The comparison is conducted on conceptual model and then verified by some SQL statements. Both methods show that LADM is valid for land administration system in Indonesia. However, some LADM concepts do not yet take place in the current practice of land administration system in Indonesia. It can be subjects of LADM application. Those concepts include vulnerable group protection (e.g. women holding shares in right is not known as a registration practice in Indonesia) and environmental protection (e.g. applications of all kind of restrictions to land). The others finding is some LADM concepts can not be adopted due to limitation of the land administration scope. Those classes are AdminParcelSet, LegalNetwork, OtherRegistrationObject, NonGeoRealEstate, and Movable classes.

The importance of this work is to contribute in validation of LADM especially in Indonesia. Since LADM is proposed as international standard, this model should be valid for whole countries in the world.

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List of abbreviations

ALKIS	Das Amtliche Liegenschaftskatasterinformationssystem (The official real estate cadastre information system)
ALPDM	ArcGIS Land Parcel Data Model
BAL	Basic Agrarian Law
BPHTB	Bea Perolehan Hak atas Tanah dan Bangunan (Land Right and Building Achievement Tax)
BPN	Badan Pertanahan Nasional (National Land Agency)
CAD	Computer Aided Design
CCDM	Core Cadastral Domain Model
CSW	Catalogue Service for Web
DXF	Digital Exchange Format
ER-Diagram	Entity Relationship - Diagram
ESRI	Environmental System Research Institute
FAO	Food and Agriculture Organization
FDGC	Federal Geographic Data Committee
FIG	Federation Internationale des Geometres (International Federation of Surveyors)
FOSS	Free and Open Source Software
GIS	Geographic Information System
HGB	Hak Guna Bangunan (right to construct building)
HGU	Hak Guna Usaha (right to cultivate land)
HP	Hak Pakai (right of use)
HPL	Hak Pengelolaan (right of management)
ICSM	Intergovermental Committee on Survey and Mapping
ISO	International Organization for Standard
IT	Information Technology
LADM	Land Administration Domain Model
LAP	Land Administration Project
MDA	Model Driven Architecture
NILS	The National Integrated Lands System
NLIS	National Land Information System
NTB	Nusa Tenggara Barat (Province of Nusa Tenggara Barat)
OGC	Open Geospatial Consortium
OMG	Object Management Group
PIM	Platform Independent Model
PPAT	Pejabat Pembuat Akta Tanah (special kind of notary in Indonesia that is eligible to create land deed)
PSM	Platform Specific Model
RRR	Right, Restriction, Responsibility
SIMTANAS	Sistem Informasi dan Manajemen Pertanahan Nasional (National Land Management and Information System)
SPOPP	Standard Prosedur Operasi Pelayanan Pertanahan (the standard operation procedure in land registration service)

SQL	Structured Query Language
UML	Unified Modelling Language
UNECE	United Nation Economic Committee for Europe
URL	Universal Resource Locator
WfMS	Workflow Management System
WFS	Web Feature Service
WMS	Web Map Service
WPS	Web Processing Service

1. Introduction

1.1. Background

Land administration is the process of recording and disseminating information about the ownership, value and use of land and its associate resource. Land administration includes land registration and cadastre. Land registration is a process of official recording of rights in land through deeds or title (on properties). It gives an answer to the question "who" and "how". Cadastre is a methodically arranged public inventory of data concerning properties within a certain country or district, based on a survey of their boundaries. It gives an answer to the questions "where" and "how much" (Henssen and Williamson, 1990).

Land plays important role on economic growth, poverty reduction, governance and sustainable development (Deininger, 2003). Considering the importance of land, many efforts have been made to provide better quality in the implementation of land administration all over the world. Three of them can be mentioned here are: future cadastre vision, guidelines for country in transition, and standardization in land administration. The Cadastre 2014 provides good vision on cadastral system. It was developed in 1994 and created a vision of how cadastres might work and look like in 2014, twenty years after it was developed (Kaufmann and Steudler, 1998). The Land Administration Guidelines were launched in 1996 by the United Nation Economic Commission for Europe (UNECE). These Guidelines define land administration as the process whereby land and the information about land may be effectively managed (United Nations, 1996). Even though it was addressed to strengthen land administration system in European countries, it is useful in all other countries in the world. The land administration domain model (LADM) was introduced to provide a reference model on land administration domain. It was submitted to International Organization for Standardization (ISO) and expected to be released in 2011. LADM covers administrative/legal components and spatial/surveying components of land administration.

Prior to the information era, cadastre was organized as separated textual indexes and cadastral map representing boundaries of parcels. Today, some countries have converted their cadastral data and land registration processes into computerized systems but some countries still operate manual systems. Countries in transition are recommended to investigate the possibility of implementing an integrated land information system (United Nations, 1996). Analogue systems however will be replaced by digital systems. Analogue systems have problems with data security, are difficult to maintenance/updating, are inefficient in terms of data storage, are slower in information extraction, and are an extra workload for land administration services. Taking experiences from disastrous Tsunami in Aceh on 2004, Winoto (2005) urges the utilization of digital information technology to back up all land data and information. Implementation of computerized systems is not a trivial activity. Many considerations should be taken into account such as user requirements, human resources, legal framework, business process reengineering, standardization, and funding.

This thesis is carried out to assess an important element when implementing computerized systems - which is standardization. LADM is international standard under development that covers the common aspects of cadastral registration. Since it is proposed as international standard, LADM needs to be tested and validated in real life situation in some countries. Indonesia is selected as study area since this country is in transition from centralization to decentralization of cadastral processes. Obviously decentralization may lead to the situation where variation on cadastral systems may exist. In absence of standards, Indonesia may have around 440 different systems. Standardization on cadastral domain will be a meaningful concept to build national land information system. Indeed, a national land information system is very important for mortgage application, environmental protection, good governance, and tenure security.

1.2. Problem statement

One of the big problems in the cadastral domain is the lack of a shared set of concepts and terminology. International standardization of these concepts could possibly resolve many of these communication problems (Lemmen et al., 2005). LADM was introduced to reduce this weakness. As a proposed international standard in the land administration domain, it should cover the common aspects of cadastral registration all over the world. Therefore, validation of this model in a specific country is a challenging research.

The Land Administration System in Indonesia is in transition from a centralized system to decentralization. The fall of authoritarian government in 1998 under President Soeharto has led Indonesia to decentralization issues. According to Law 22/1999, land governance is a decentralization subject (Presiden Republik Indonesia, 1999). The polemic arose whether land registration and cadastre are under local government or not since land governance is a general term. Through Government regulation number 25/2000, the role of local government was limited outside land registration and cadastre (Presiden Republik Indonesia, 2000). Subsequently, Presidential Decree number 34/2003 asserted that land registration and cadastre is not under jurisdiction of the local government (Presiden Republik Indonesia, 2003). Nevertheless, the aspiration to decentralize land administration was never stopped and finally the house of representatives promulgated law number 32/2004 that stipulates that land administration shall be carried out by local government (Presiden Republik Indonesia, 2004). However the implementation was postponed until now. According to Pusat Data dan Informasi Pertanahan Badan Pertanahan Nasional Republik Indonesia (2007), there are 440 local government within Indonesian territory and this number tends to increase. Decentralization can lead to the vast variation on LAS within this country. Current practice of local autonomy shows that often local government suddenly takes decisions on many issues using new or reformed local organization and information processes (de Vries, 2007).Ultimately, in the absence of standard data model, 440 different models may appear. The risks of having several models within a country are:

1. Difficulties in the development of National Land Information System (NLIS). In general NLIS will serve the citizen to get an easy access to the nation wide cadastral data from anywhere. A number of activities will benefit from it such as mortgage, transparency of government, environmental protection, emergency response, development of infrastructure, and disaster management.
2. Redundancy of software development and maintenance. The client-server database management system gives a possibility to perform concurrent use of a single database server.

Database operation executed from client-side via user friendly interface either through web page form or desktop application. The development of client application obviously depends on the database design. Different database design requires different client-side application.

To overcome this problem, introduction of LADM can be a good solution. However, validation and some adaptations to the model need to be done. Legal framework in a particular country is one thing that can not be interfered by LADM. Hence, a validation process is important to get a clear understanding on what classes are needed in specific situation in a country and what classes are not. Adaptation is required because LADM provides the core classes and minimum set of attributes. It should be extended to fit the land administration system requirements, e.g. in Indonesia.

1.3. Research objectives

The main objective of this research is to validate The Land Administration Domain Model in Indonesia. Validation may benefit both a specific country (in this case Indonesia) and LADM itself. If the validation shows that some modifications are needed and if these modifications are also valid to other countries, then those modifications may be adopted to new version of LADM. The more validations are carried out, the more acceptances may be achieved. Through several validations from different countries, LADM is expected to become a factorial used standard in land administration all over the world. A country will also benefit from this process. If its specific conditions are accommodated into the model and they adopt this model, they may get wider support from software developer and even more can adopt Free and Open Source Software (FOSS). Current initiative from FAO is trying to develop FOSS in the land administration domain (The University of Otago, 2008).

Despite of main objective mentioned above, there are secondary objectives:

1. To introduce model driven architecture on land administration domain in Indonesia with regard to the international standard
2. To provide a specific country profile for the Land Administration Domain Model.
3. To identify the user requirements in Land Administration System in Indonesia.
4. To create a prototype based on LADM with regard to the user requirements.

1.4. Research questions

According to the research problem, some research question can be formulated as follows:

1. Is LADM valid for land administration system in Indonesia?
2. What LADM concepts are possible to be applied in Indonesia?
3. What LADM classes need to be implemented and what classes not?
4. What extensions of LADM (including classes, attributes and associations) need to be implemented in Indonesia?
5. What are the challenges when implementing the land administration domain model in Indonesia?

1.5. Conceptual framework

Rieger et al (2001) provides some inputs to the decision makers at all administration level for developing viable options in the process of transforming National Land Agency (Badan Pertanahan Nasional, in short BPN) into a functioning land administration system. It recommended the development of a mid-term decentralization concept for land administration. At the same time, it recommended the integration of BPN into National Geographic Information System. The same report also recommended central BPN to build standards, but BPN has less attention on this so far. Almost ten years after decentralization issues, BPN produced two standards only. One is standard on operation and service procedure, the second is standard for graphical data interchange. The standard operation and service procedure contains workflow, duration, product and person in charge of a specific duty. The standard for graphical data interchange consists of how spatial data should be structured. It adopt topological data model and stored in DXF format. The similar geographic features organized into the same layer with standard name. Even though this standard successfully supports some activities such as mass adjudication, post tsunami reconstruction in Aceh and development of National Land Management and Information System (Sistem Informasi Manajemen Pertanahan Nasional, in short SIMTANAS), but this standard is lacking updating capabilities. If this standard can be transformed into spatial database, it will be easier to maintain. In combination with standard operation and service procedure, BPN can impose data updating / maintenance in digital environment through Business Process Management Workflow.

In the heterogeneous system, standardization is a key solution to unify them. Concerning that decentralization possibly lead to heterogeneity of system, standardization should be taken into account. Standardization may achieved by service-based interoperability or harmonization of the underlying data model. Both of them will be discussed bellow.

1.5.1. Service-Based interoperability versus standardization data model

Standardization data model in cadastral domain become possible because the land database only available in some local offices, some of them not even stable. They are still possible to be altered. In absence of standardized data model, the National Land Information System may rely on interoperability service such as Web Map Service (WMS) or Web Feature Service (WFS). If there are n local offices then there should be n services developed as depicted in figure 1.

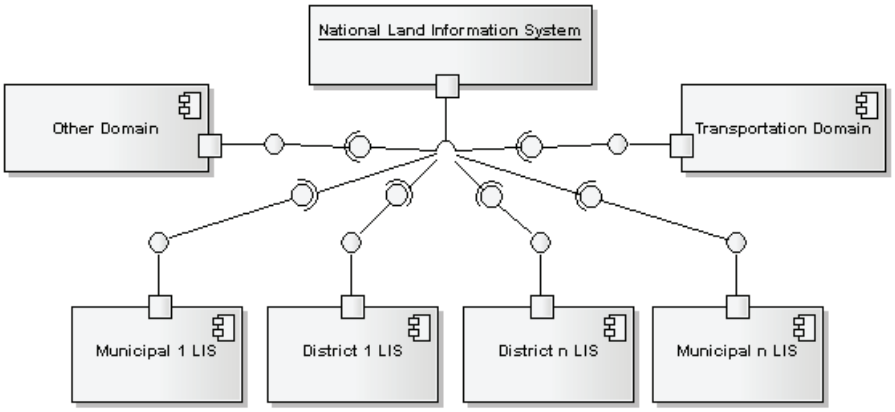

Figure 1. National LIS without standardized model

The development of National Land Information System with standardized data model can be figured out as follow:

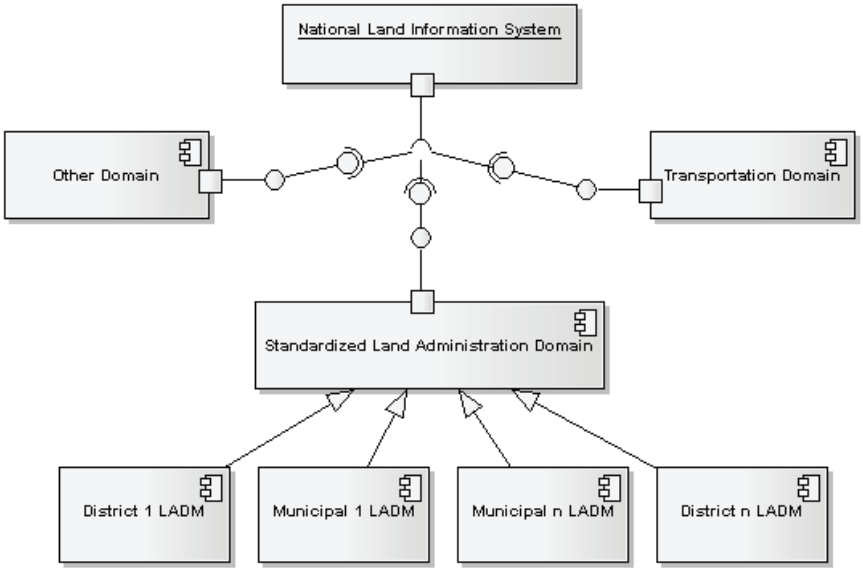

Figure 2. National LIS with standardized model

A simple comparison between service-based interoperability and standardization of data model is made below based on some aspect:

Aspect	Service-based interoperability	Harmonization of data model
Functionality	+	-
Development	-	+
Maintenance	-	+
Human Resource	-	+
Complexity	-	+

Table 1. Comparison between interoperability of service and harmonization of datamodel

From the table above, minus sign means advantage and plus sign means disadvantage. If each local office creates its own model, the model may be fully compatible with their local conditions. It may give full functionality to a specific region. However, the development process might be very expensive because developed software is dedicated to a specific data model. Maintenance also becomes expensive activity. If a change on legal framework takes place, every local office may need to alter their software. Both development and maintenance require skilful persons - which is another lack. Finally, development of NLIS in the large variety of sub systems will produce a very complex system. Some developed countries like Australia, Germany, and The Netherland have tried to harmonize a number of domain models within their jurisdiction (van Oosterom et al., 2006). From some arguments above, I argue that the harmonization of data model if the better choice rather than using interoperability service, especially within a particular domain. Further question may arise, what model should be adopted? There are several initiatives to standardize cadastral domain as follow:

1. The Working Committee of the Surveyors Authorities of the States of the federal Republic of Germany start developing a new conceptual data model based on international GIS standards named ALKIS in 2002.
2. The Cadastral Subcommittee of the US Federal Geographic Data Committee (FGDC) developed the Cadastral Data Content Standard for the National Spatial Data Infrastructure in 1999. This standard has been linked to ArcGIS Land Parcel Data Model trough NILS projects.
3. The Intergovernmental Committee on Surveying and Mapping (ICSM) has developed a National Cadastral Data Model version 1.1 in 1999.
4. FIG has established version 1.0 of the core cadastral data model in 2006, later known as Land Administration Domain Model.

The section below will compare two existing model in cadastral domain which are Land Administration Domain Model and ArcGIS Land Parcel Data Model. The two are selected because both of them have international reputation and influence.

1.5.2. The LADM versus ArcGIS Land Parcel Data Model

This section will try to compare two prominent data model on cadastral domain. LADM is proposed by FIG to be an international standard while ArcGIS Land Parcel Data Model (ALPDM) initiated by ESRI which actively provide support to data model in several domains including cadastre. The table below shows comparison between LADM and ALPDM from several aspects:

Aspect	ALPDM	LADM
Language	ER-Diagram	UML
Package	Cadastral	Legal/Administrative and Cadastral package as modular system
Implementation	Tied to specific software	Neutral
Parcel's Spatial Description	Topological Rules	Topological Rules, Spaghetti, Point
History	Not supported	Hybrid (event based and state based)
3D object	Not Supported	Supported
Building Object	Available	Available
Taxation Support	Yes	Yes
Reviewing and testing	Mostly in US	Several countries including Netherlands, El Salvador, Bolivia, Denmark, Sweden, Greece, Australia, Nepal, Egypt, several African and Arab countries have reviewed the model. Iceland, Slovakia and Portugal have done a real test.

Table 2. Comparison between LADM and ALPDM

From the table above, significant differences occur on language, number of packages, implementation, parcel's spatial description, history, support on 3D object, and reported testing. Compared to ER-Diagram, the Unified Modelling Language (UML) is a better approach. The main advantages of having UML diagram is the possibility to work at all level of database design process in a team. The UML covers both dynamic and static behaviour of the system while ER-Diagram covers static behaviour only. The UML support what ER-Diagram support and beyond. The UML was built with ER in mind. ER modelling has existed for a long time, and when the UML was created, the creator built it as a superset of ER notations (Naiburg and Maksimchuck, 2001).

The number of packages does also matter. If the standardization only defined on cadastral part, information access to legal/administration information can vary again. Land Administration covers both the administrative/legal aspect and the cadastral aspect, both packages must be standardized. An implementation that is tied to specific software is not a good choice. The model should be able to be implemented in any software; including Open Source Software. Open Source Software is a very good idea to gain knowledge about the technology itself and a way to create a product that meets specific requirements of developing countries (Camara and Fonseca, 2007). Linus Torvalds, the chief of Linux developer was taken question by Weerawarana and Weeratunga (2004) stated that the difference being that with the proprietary solution, you'll never catch up, and you'll have to pay forever, without ever learning anything yourself.

The choice of representing spatial feature is influenced by some factor such as ability of software, and data completeness. The fact that not all spatial database management system support topological data model may lead to the use of spaghetti data model to represent parcel boundary. In case sufficient data is not available to describe parcel boundaries, point or even text representation can be used to represent parcel location. Finally, availability of alternative means to represent spatial feature lead to flexibility of using spatial database management system

Concerning history, it become important especially if legal framework stipulate it. In a country with deed registration, history also has special meaning since the registration only register the transaction, not the consequences of transaction. It means that the system have to be able to trace the previous transaction. The 3D object is also sometimes stipulate in the legal framework. In deed, to be able to accommodate several country both history and 3D object should be included in the model.

Moreover, acceptance from various countries is very important. In the future, the need to share information across nation maybe will increase. Even though it look like interoperability service approach is better, but the standard model my take important role of sharing ontology.

Taking into account some aspect above, LADM is likely more promising one especially for developing country as Indonesia.

1.6. Methodology

Based on the research questions above, research methodology has been designed as follow:

1. Literature study has been carried out related to:

   a. Cadastre vision
   b. Standardization on land administration domain and previous study on it,
   c. Land Administration System in Indonesia as well as international directive on land administration system, and;
   d. Model validation and application.
2. A case study has been performed to collect information about specific requirements and to get cadastral data samples for the validation purpose. Case study will include some activities are:
   a. Collect user requirements on land information system from citizen, internal BPN employee as land registration operator, government organizations that have interest on cadastral data, and private sectors perspective. The user requirements that are gathered through questionnaires and interviews will be verified if they are accommodated by LADM.
   b. Collect actual issues on land administration system in Indonesia from citizen, internet pages, field observation, and other documents. Documents include existing data model, legal framework, and pictures.
   c. Extracting data from existing database.
3. Validating the LADM. Robinson (1994) provides three model validation methods. Briefly, a model can be validated through face validity, comparison with the real system, and comparison with other models. Those validation methods are reviewed in section 2.6. Validation process consists of three following activities:
   a. Create a prototype of LADM to be used on face validity. Prototyping process including creating database, populating database records with person, legal/administrative, geometry and topology, immovable, and surveying packages.
   b. Demonstrate the model. Demonstrate the model is one of face validity methods. Demonstration of the model is intended to proof credibility of work.
   c. Comparison with existing model. Comparison with other model is obtained through comparison with similar simulation models, in this case existing model.
4. Applying LADM concepts with regard to current issue on land administration system in Indonesia.
5. Identify the challenges of adopt LADM in Indonesia.

This research will use some software as PostgreSQL and PostGIS for storing spatial database, Enterprise Architect for modelling, and map visualization tools. The map visualization tools might be desktop application or web based application. The research methodology is tailored to answer research questions as shown bellow:

	Method 1	**Method 2**	**Method 3**	**Method 4**	**Method 5**
Question 1	✓	✓	✓		
Question 2	✓	✓		✓	
Question 3	✓			✓	
Question 4	✓			✓	
Question 5	✓	✓			✓

Table 3. Research question and research methodology matrix

1.7. Research scope

The scope of this research is defined as following:

1. The version of Land Administration Domain model that is used is Working Draft 1 presented on February 01, 2008. It is the first working draft.
2. The registerObject class of this research covers 2D parcel object only.
3. The physical model is presented in one municipality only. Real data from the Central Jakarta municipality have been loaded for testing and validating.

1.8. Thesis structure

Chapter 1: Introduction
This chapter consists of research background, problem statement, research objectives, research questions, conceptual framework, methodology, and reseacrh scope.

Chapter 2: Literature review
This chapter review of some literatures that support this research.

Chapter 3: The Land Administration Domain Model
This chapter consists of reference about Land Administration Domain Model. In this chapter, the complete package of LADM is presented, including description of every class.

Chapter 4: Land administration system in Indonesia
This chapter describes about the land administration system in Indonesia. It presents legal framework for land administration system in Indonesia, customary tenure system which is the genuine tenure system in Indonesia, and current practice.

Chapter 5: Analysis of user requirements
This chapter includes the user requirements and its analysis. User requirements were collected during field work. The analysis is based on LADM conceptual model. Analysis of user requirements on conceptual model is intended to achieve efficiency. If conceptual model can not accomodate user requirements, it likely that physical model will not useful at all.

Chapter 6: Validation and application of LADM
This chapter describes validation process and discuss possibilities to apply some LADM concepts in real life situation. Finding about the needs to introduce new classes as extension of LADM is discussed here.

Chapter 7: Conclusion and recommendation
This chapter presents conclusions and recommendations. In this chapter, the research question that is posed in chapter one is revisited. Contribution of this work is also included in this chapter.

2. Literature review

2.1. Introduction

This chapter is intended to provide some existing literature that supports this research. The emergence of the Land Administration Domain Model is triggered by the Cadastral 2014 vision which gave an abstract notion about land administration modelling (Kaufmann and Steudler, 1998). The modelling approach to bridging non-technical end-user / managers and software analyst is overviewed in section 2.3. Overview about standardization issue in cadastral domain is included in section 2.4. The implementation of standardization in cadastral domain may also lead to changes of land administration system, especially in organizational structure, policy and business process. UNECE provides the guide steps to do such changes (United Nations, 1996). One of the steps is user requirements identification. The last section discusses about previous work related to this research.

2.2. Modern cadastre vision

One of the prominent visions on cadastre is Cadastre 2014 (Kaufmann and Steudler, 1998). One of major aims of the Cadastre 2014 is to improve the information about the legal situation of land and then strengthen tenure security. When it was issued, Cadastre 2014 is new approach to cadastral domain. The vision of Cadastre 2014 consists of six statements and six principles of future cadastre.

Cadastre 2014 statement mentioned the role of modelling. The position of Cadastre 2014 and LADM in term of modelling can be compared with contract and implementation. Cadastre 2014 provides modelling concept in abstract notion, and must be implemented into real model which LADM did. LADM has gone one step further with the specification of the cadastral model. Kaufmann (2004b) concluded that the basic consideration between CCDM and Cadastre 2014 is not differ much. Furthermore he concludes the development of the CCDM shows that with every step more elements of Cadastre 2014 are included. A trend in direction of Cadastre 2014 can be identified.

Another aspect of Cadastre 2014 regarding its principles is also important to be discussed here. Cadastre 2014 consider that the legal independence is the key item to realize Cadastre 2014 (Kaufmann and Steudler, 1998). Legal independence principle is intended to localize a certain layer with regards to specific law/regulation. Through local independence concept, Cadastre 2014 provides support to informal and customary rights, occupation rights, and indigenous rights (Kaufmann, 2004a). Those rights and area where they are effective is well known. However, they can be overlap to another legal land objects, such as private property rights, public rights and restrictions, and concessions for the exploitation of natural resources. The legal entities that are living over those areas may have living, hunting and fishing rights. So the Cadastre 2014 concept can show overlapping rights and serve to formalize the situation, to regulate transactions, to monitor and to improve the ambiguous situations (Kaufmann, 2004a). Cadastre 2014 manages this condition by defining individual layer for each land object under the same law. This concept is modelled as restriction class in LADM. For example, the legal right that is attached to a particular land can be restricted by customary right or public law.

Today, six years before 2014 some countries have implemented Cadastral 2014 vision, and some are still struggling to realize the vision. A standardized model may help the struggling countries to realize cadastre 2014 visions, and ultimately increase people welfare through tenure security. De Soto (2000) describes the positive effect of functioning cadastral system within stable formal property system.

2.3. The model driven architecture

The Model Driven Architecture (MDA) is a framework for software development defined by the Object Management Group (OMG). Within MDA the software development process is driven by modelling activity. The MDA development life cycle is initiated by describe the user requirements, mostly in text. Based on user requirements, the artefacts are created. The artefacts are formal models that can be understood by both human and computers. The first model is Platform Independent Model (PIM) with a high level of abstraction and independent of any implementation technology. When the PIM ready, it can be transformed into one or more Platform Specific Models (PSM). A PSM is tailored to specify a system in term of the implementation constructs that are available in one specific implementation technology. The last step is the transformation of each PSM into code. The MDA process may look suspiciously much like traditional development, but there is a crucial difference. Traditionally, the transformations from model to model, or from model to code, are done mainly by hand. Many tools can generate some code from a model, but that usually goes no further than the generation of some template code, where most of the work still has to be filled in by hand. In contrast, MDA transformations are always executed by tools. What's new in MDA is that the transformation from PIM to PSM is automated as well. Kleppe et al. (2003) address benefits of MDA as follow:

1. Productivity, developers focus on PIM so they can work independently of details and specifics of the target platforms, there is a lot of technical detail that they do not need to bother with.
2. Portability, the same PIM can be automatically transformed into multiple PSM for different platforms. Everything that is specified at the PIM level is therefore completely portable.
3. Interoperability, when PSM are targeted at different platforms, they cannot directly talk with each other. One way or another, we need to transform concepts from one platform into concepts used in another platform. This is what interoperability is all about. MDA addresses this problem by generating not only the PSM, but the necessary bridges between them as well.
4. Maintenance and Documentation, the PIM is used to generate the PSM, which in turn is used to generate the code. The model is an exact representation of the code. Thus, the PIM fulfils the function of high-level documentation that is needed for any software system.

The OMG defines a number of modelling languages that are suitable to write either PIM or PSM. The most well-known language is UML. This is the most widely used modelling language. UML is a general-purpose visual modelling language that is used to specify, visualize, construct, and document the artefacts of a software system (Rumbaugh et al., 2004). In the UML diagram, the following are usually shown:

1. Classes,
2. Attributes of classes,
3. Association between classes,
4. Association name or role of class,
5. Optional direction of associations,

6. Multiplicities, and;
7. Method or constraints.

However, Arlow et al (1999) found it difficult for non-technical end-users, managers, and business domain expert to understand the UML syntax. The literate modelling approach may help such parties to understand UML semantics. Literate Models are UML diagrams that are embedded in texts explaining the models (Arlow et al., 1999). The embedded text can be a description of the model, as well as documentation of the model. It is quite common that after the model has been written few months ago later the analyst who wrote the model is unable to explain the business requirement behind the model. The literate model is a good choice in the cadastral domain modelling because of the gap knowledge between parties as mentioned before. United Nation (1996) pointed out that gaps, many people trained in land management may feel uncomfortable with modern technology while many system analysts and computer technicians do not have an in-depth understanding of land tenure.

2.4. Standardization in land administration domain

Almost every country in the world operates different cadastral system. Some countries operate fixed boundary while the others operate general boundary. Some country may comfortable with deed registration and the others prefer to adopt title registration. The other differentiation may come from organizational approach either centralization or decentralization. The purpose of cadastral can also be different. They might be used for fiscal or legal purpose. However, among those different, there is a common concept which is relation between people and parcel. This common concept led to the idea of standardization in cadastral domain.

A standardized cadastral domain is targeted to achieve two important goals (Lemmen et al., 2004):

1. Avoid duplication effort by providing extensible basis for efficient and effective cadastral system development based on model driven architecture.
2. Enable involved parties, both within one country and between different countries, to communicate based on the shared ontology implied by the model.

In 2002, van Oosterom and Lemmen (2002) proposed a cadastral domain model the so called Core Cadastral Domain Model (CCDM). Since it was proposed the model has been evolved base on discussion at workshops with experts and experiences from case studies in several countries. The last version of CCDM is known as Version 1.0 of the FIG Core Cadastral Domain Model. In this model, there is no direct relationship between the Person class and the RegisterObject class but via RRR (Right, Restriction, and Responsibility) class (Lemmen and van Oosterom, 2006). Currently the model has been submitted to International Organization for Standard (ISO) as new work item proposal (ISO/TC 211 Geographic Information/Geomatics, 2008). The model is given a new name which is Land Administration Domain Model since the term cadastral was not perceived to cover both the legal/administrative side and the geometric side. A significant effort has brought the model compliant with ISO 19107 Spatial Schema now.

The model presents both legal/administrative part and cadastral objects. It does not mean that the model must be implemented as a whole in a single organization. The model is flexible enough to be implemented as distributed set of geo-information systems, and most likely the model will be

implemented and maintained by several organization e.g. municipality, land agency, mapping agency, etc. The packages reflect that possibility.

The hybrid approach to handle historical aspects of the object instances was introduced in the model which are event-based modelling and state-based modelling (van Oosterom et al., 2006). The latest model has been adjusted to ISO 19108 Temporal Schema. However, the dynamic model (use case diagram representing land administration processes or procedures) have not been provided yet, this could be a further development in standardization of cadastral domain (van Oosterom et al., 2006).

2.5. Determination of user needs

The determination of user needs is one of the operations which needs to be addressed when implementing the new land administration system (United Nations, 1996).

The users of land administration system can be categorized into internal and external users. Internal users are member of the institution which regulates or operates the land administration system, usually a governmental institution, while external users are anybody else. In deed, land administration system should meet the needs of good government. The land administration system must satisfy non-governmental institution and general public as well. Before altering an existing system or introducing a new one, it is essential that the requirements of those who will use or benefit from the system are clearly identified (United Nations, 1996).

2.6. Validation and application of a model

Robinson (1994) define model validation as a process to assess both accuracy and capability of a model to meet the objectives of the simulation for which it being used. Further more, Robinson (1994) provides three validation which are face validity, comparison with real system, and comparison with other models.

Face validity take form of watch model run for an hour and demonstrate the model. By watching a model run for an hour, some question can be raised to validate the model such as what occurrences is expected to be happen, why a machine always idle, and why a large queue building up.
By demonstrating a model, some feed back is expected to be obtained to increase model accuracy and ability to meet the project objectives.

Comparison with the real system may take form of comparison with historic data, input/output relationships, and turing test. Historic data help to judge how close the average of model result match to real data. Concerning input/output, the relationships between them should be the same for the model as for the real system. In a turing test the model reports are made to look exactly the same as the reports provided by real system.

Comparison with other models particularly useful when the real system does not exists. Other model can be a mathematical model, deterministic model, and similar simulation model. Mathematical model is unlikely able to predict the outcome of model exactly, otherwise the simulation would probably not have been built in the first place. However, by simplifying the simulation it may be possible to draw a

direct comparison with a mathematical model. Deterministic model is a very useful means for obtaining a greater understanding of the facility being modelled The last method make use of existing similar simulation model that is considered to be valid before any comparison are performed. Model results among them can be compared to assess validity of new introduced model.

Among those validation methods, two methods are suitable for this research. The selected methods consists of demonstrate the model and comparison with similar simulation model.

Ofxord dictionary defines application as the practical use of something, especially a theory, discovery, etc. Application of LADM therefore can be defined as practical use of LADM classes for land administration system in Indonesia. Some classes might take place on land administration system already, some other may not. Possibilities to apply those class which uncovered by current land administration practice is intended to escalate land administration role on development process in Indonesia.

2.7. Related research

The related research presented here is to give an overview of what other peoples have done in the development of cadastral domain modelling. The research in general can be differentiate into two groups which are the application of cadastral modelling to a specific country (section 2.6.1) and application of cadastral modelling based on specific technology (section 2.6.2).

2.7.1. Application of CCDM to specific country

Hespanha et al (2006) describes the application of the core cadastral domain model (CCDM), the predecessor of Land Administration Domain Model, in the Portuguese cadastre. The importance of research is to evaluate the FIG CCDM by applying the model in specific country. Hespanha et al (2006) found that some classes presented in the CCDM are not all available in the Portugal cadastral system, but it is assumed that they will be necessary in the future. On the contrary some classes that exist in Portuguese System were not available in the CCDM. In that case, the new class was placed in the most proper package. The new introduced classes might be adopted by CCDM if the classes are also valid in other countries.

In addition to the static classes provided by CCDM, Hespanha et al (2006) included dynamic behaviour of the cadastral system in Portugal. Currently, CCDM or LADM has not included such things in their diagrams. However, the dynamic behaviours can be very important especially in a region that provides a regional initiative on land transaction such as COST Action G9 in Europe (COST Office, 2006). Including the dynamic behaviour in a specific country may be a good idea when a country wants to adopt the CCDM as national standard. The dynamic behaviour that is presented in use case diagram is very useful to understand for who is responsible for what activity.

Hespanha et al (2006) concluded that most of the classes and its associations were preserved although some adaptation took place. The CCDM that integrates land registration and cadastre show the same development path with the aims of Portuguese cadastre.

The CCDM has been reviewed in some other countries including The Netherlands, El Salvador, Bolivia, Denmark, Sweden, Greece, Australia, Nepal, Egypt, Iceland, and several African countries as well as several Arab countries (van Oosterom et al., 2006). The real test has done in Iceland, Portugal, and Slovakia.

2.7.2. Application of CCDM based on specific technology

Hespanha et al (2008) describe some efforts to transform Platform Independent Model (PIM) to Platform Specific Model (PSM). The LADM provides the basic class and association of cadastral model. At this level, LADM considered as PIM means that LADM independent from platforms and specific database schema. As PIM, LADM is absolutely has no meaning for creating information system. Thus, transformation is needed to convert PIM into PSM. PSM refers to specific hardware, platform and database management system.

The importance of such a research is in bridging the gap between Model Driven Architecture (MDA) and software generation especially when talk about spatial application. The supporting tool to generate software from MDA is available, but lack of support to the spatial data types. The research may also importance to solve the problem related to synchronizing generated software after changing UML diagrams.

Other efforts have been done such as application of CCDM in open source software (Ingvarsson, 2005) and implementation of CCDM in a distributed environment using OpenGIS standards (Rutamu, 2006).

3. The Land Administration Domain Model

3.1. Introduction

This chapter will describe classes and packages in LADM. The LADM is expressed in UML class diagram. It makes use of literate modelling technique with explanation about packages, classes, multiplicity, association, attributes, and constraints. The complete class diagram of LADM is included in this chapter. Colour of the class indicates to which package it belongs. The version of LADM that is used is Working Draft 1, February 2008.

3.2. The LADM scope

The land administration domain model is a UML diagram presenting object classes and their relationship. All together provide an abstract conceptual schema in land administration domain. It defines a reference Land Administration Domain model covers basic components of land administration. The LADM also contains some terminologies for land administration based on national and international concepts. The LADM is not intended to interfering legal framework in a particular country. Some data may come from other sources beyond land administration domain such as person data. In this case, the LADM merely refer to those data and standardization of such data is beyond the scope (system boundary) of LADM.

3.3. The LADM packages

The LADM consists of five packages. The package is marked by specific colour in the class diagram as follow:

1. Blue for immovable package,
2. Pink for surveying package,
3. Purple for geometry and topology package,
4. Green for person package, and;
5. Yellow for legal/administrative package.

The arrangement of class into package is intended to be able to present LADM in comprehensive part yet maintain and develop packages independently, and being able to use a package to implement one type of functionality. The packages are not necessarily implemented as a whole in one organization. It allows implementation and maintenance of each package in different organization according to their responsibility. Each package is explained in the sections below.

3.3.1. Immovable package

The immovable object maintains two main categories are land or space (3D space) and other objects. The immovable class is abstract class. It is specialize into instanciable class as follow: RegisterParcel, TextParcel, PointParcel, SpaghettiParcel, OtherRegisterObject, NonGeoRealEstate, LegalSpaceBuilding and OtherRegisterObject. RegisterParcel is parcel subject to registration.

TextParcel, PointParcel, and SpaghettiParcel are non partition region. It is used to represents parcels having low measurement quality. OtherRegisterObject represent other than parcel or building subject to registration, for instance gas network, underground cable, etc. LegalSpaceBuilding is legal space around building.

3.3.2. Surveying package

Surveying package consists of SurveyPoint and SurveyDocument classes. SurveyPoint populate observed point of regeistered parcel. The SurveyDocument provide spatial description of register object.

3.3.3. Geometry and topology package

The LADM relies on ISO standard 19107 “Geographic Information – Spatial Schema” to represent geometric description. The spatial description of spatial feature for example parcel is constructed by face. Every face is topologically close and bounded by edges and every edge is bounded by two nodes at the intersection. However edges belong to different time span may across without node. Within topology structure, there is no gap or overlap in the partition.

3.3.4. Person package

Person package maintains Person, GroupPerson and Member classes. Person can be natural person or non natural person such as company, government organization, foundation, etc. Moreover, two or more natural person can constitutes group of person. Member is an association class of Person and groupPerson class. Basically it holds share information of each group member.

3.3.5. Legal/administrative package

The main class in this package is RRR classes. It is an abstract class specialize into three instanciable class are Rights, Restriction and Responsibility class. Right is compulsory association between register object and person. There is always at least one instance of right in which the type of right represent the strongest (or primary) right for instance ownership, freehold or leasehold. Connected to this strongest right certain interest can be added or subtracted from this strongest right (van Oosterom and Lemmen, 2006)

3.4. The LADM classes

The LADM class consists of small set of attributes, methods and constraints. This way allows users to add more specific attributes, methods, constraints and even completely new class to fit with national requirement. Conversely, some classes may be omitted during implementation when users find such classes are not recognized in their country. Following are default class and attribute for LADM.

3.4.1. Movable class

This is movable class such as plane, ship. In some countries, movable object subject to mortgage is treated as cadastral object.

3.4.2. Immovable class

Immovable is an abstract class, it has no instance. The immovable is defined as a single area or more particularly a volume of space, under homogenous real property rights and unique ownership.

3.4.3. ImmovableComplex class

ImmovableComplex is aggregation of immovable objects subject to registration. Basically immovable complex class does not have any attribute. However, since this class is specialization of immovable class, it will inherit attribute from immovable.

3.4.4. RegisterParcel class

RegisterParcel is parcel subject to registration. Register parcel is subclass of parcel and immovable. The attributes of it class are:

- legalSize: area that is issued to the public as in legal document. The legal area might be different than computed area from its geometry. The differences may reflect the accuracy of previous measurement.
- parcelName: locally known name of the parcel.

3.4.5. Parcel class

Parcel is a single area of land, or more particularly a volume of space, under homogenous real property rights. Parcel is an abstract class so it is not instantiable. However this class bequeath some attribute to its subclasses are:

- computedSize: an area computed from its spatial description.
- dimension: dimension of coordinate system (2D or 3D).
- spatialDescription: spatial representation imported from ISO 19107.
- urban: boolean indicate whether a parcel in urban or rural area.

3.4.6. ServingParcel class

Serving Parcel is a parcel that is owned in joint ownership by the owner of the register parcel. Serving parcel is subclass of parcel and associated to register parcel. At least two register parcels is served by serving parcel. Basically serving parcel does not have attribute but inherit from parcel class.

3.4.7. NPRegion class

NPRegion is a non-partition region, a region that covers parcels which are not topologically structured such as spaghetti parcels, point parcel and text parcel. Basically this class does not have attribute but inherits from parcel class.

3.4.8. TextParcel class

TextParcel is used to store information about parcel which its location is described in word. Text parcel has one attribute which is estimatedArea. Text parcel is associated with non-partition region.

3.4.9. PointParcel class

PointParcel is parcel that is its location known from a single point only. Like TextParcel class, point parcel has one attribute only which is estimated area. Point parcel is associated with non-partition region.

3.4.10. SpaghettiParcel class

SpaghettiParcel is parcel which has incomplete boundary or its boundary is topologically unstructured. It has one attribute which is legalSize. Spaghetti parcel is associated with non-partition region.

3.4.11. OtherRegisterObject class

OtherRegisterOject class represents immovable object beyond parcel and building subject to registration. The attributes are:

- computedSize: area that is computed from its geometry.
- dimension: dimension of coordinate system.
- legalSize: area that is issued to the public as in legal document.

3.4.12. LegalSpaceBuilding class

LegalSpace building is a bounding box (envelope) surrounds physical building subject to registration. Class attributes are:

- compNum: an identifier for the space.
- dimension: dimension of the legal space building.
- extAddressId: an identifier to external post address.

3.4.13. BuildingUnit class

BuildingUnit is part of legal space building. A number of building units compose legal space building. Building unit can be common area or individual property (apartment). The attributes are:

- extAddressId: identifier to external post address.
- type: unit type, can be common or individual.
- unitNum: the identifier of building unit.

3.4.14. AdminParcelSet class

AdminParcelSet is aggregation of parcels constitute a larger area. The area can be an administrative area such as municipality, province or even state. The basic attributes of this class are:

- hirarchiLevel: the order of area among administrative hierarchy within a country
- name: name for it area.

3.4.15. LegalNetwork class

LegalNetwork is area/space surrounds legal network subject to registration. The legal network is subclass of other register object. Attributes for this class are:

- belowSurface: boolean that indicate whether the network below earth surface or not.
- dangerous: boolean that indicate whether the network dangerous or not.

- extPhysicalNetworkLink: provide information to external data related to the network
- geometricQuality: precision of geometric data.
- status: status of the network that can be in use, out of use, or planned.
- type: type of network. The value might be chemical, electricity, gas, telecommunication, etc.

3.4.16. SurveyPoint class

SurveyPoint is a coordinate observed from field measurement. The survey point forms topological primitive such as node and edge of parcel. Survey point is associated with point parcel, spaghetti parcel, legal space building and other register object. A two dimension area such as parcel or building is constituted by at least three survey points. A three dimension space is constituted by at least four survey points. The attributes of survey point are:

- dimension: dimension of coordinate system.
- locationOrig: a coordinate from where the measurement is based from.
- locationTransf: a coordinate to where the original measurement is transformed to.
- pointType: enumeration type of point, can be end point, mid point.
- quality: quality label.
- transformation: transformation that is used to transform origin location to new location

3.4.17. SurveyDocument class

SurveyDocument is a document contains field measurement data and sketch. The attributes are:

- measurements: observation and measurements as a basis for mapping and reconstruction.
- number: identifier of survey document.
- quality: quality label.
- surveyDate: the date when the survey was taken.
- type: document type, can be field sketch or relative measurement.

3.4.18. GroupPerson class

GroupPerson is an aggregation of natural persons. The difference between non-natural person and group person is that the first is intended to represent instances such as organizations, companies, government institutes (with no explicit relationships to other persons), while the second is intended to represent communities, cooperation, and other entities representing social structures (van Oosterom et al., 2006). GroupPerson class inherits attributes from person classes.

3.4.19. Member class

Member is an association class of Person – GroupPerson relationship. It attributes is share represent the share of the member. The total amount of share among members of group person must be exactly one.

3.4.20. RRR class

RRR stand for Right/Responsibility/Restriction. RRR class is an abstract class mean it has no instance. The instance of this class can be right, responsibility or restriction. Attributes of RRR are following:

- share: share of the right owner. The total amount of share must be exactly one.

- timeSpec: time when the right is effective in time sharing ownership. It can handle reccuring pattern of temporal representation such as every week, every summer, etc.

RRR class is associated with Person, RegisterObject and LegalDocument. It is subclass of VersionedObject class.

3.4.21. Right class

Right class is the real property right based on legislation. Right can be statutory right, customary right. Right class has one attributes which is right type. The value of right type can be lease, occupation, ownership, water right, grazing, etc.

3.4.22. Restriction class

This is a legal restriction to property right. Restriction allows somebody else to do something to a particular right such as impose zoning or land use planning. Attributes of this class is restrictionType. Restriction type can be servitude, restriction to erect buildings, or restriction to change a monumental building architecture.

3.4.23. Responsibility class

This is for responsibility to perform maintenance. Responsibilities mean that the owner should actively fulfil their obligation over their land. Attributes of this class is responsibilityType. Responsibility type can be maintenance of monument, maintenance of waterway, etc.

3.4.24. Mortgage class

This is a class of mortgage on a right. Mortgage class is associated to Right, Legal Document and Person class with three attributes are:

- amount: amount of money of the mortgage.
- interest: mortgage interest.
- ranking: ranking order in case more than one mortgages applied to a right.

3.4.25. LegalDocument class

LegalDocument provides legal fact which is evidence of a person's right to land. The attributes are:

- number: identifier of legal document.
- text: content of legal document.
- type: type of legal document, the value can be deed, mortgage or title.
- salePrice: purchase price.

The complete class diagram of LADM is shown bellow.

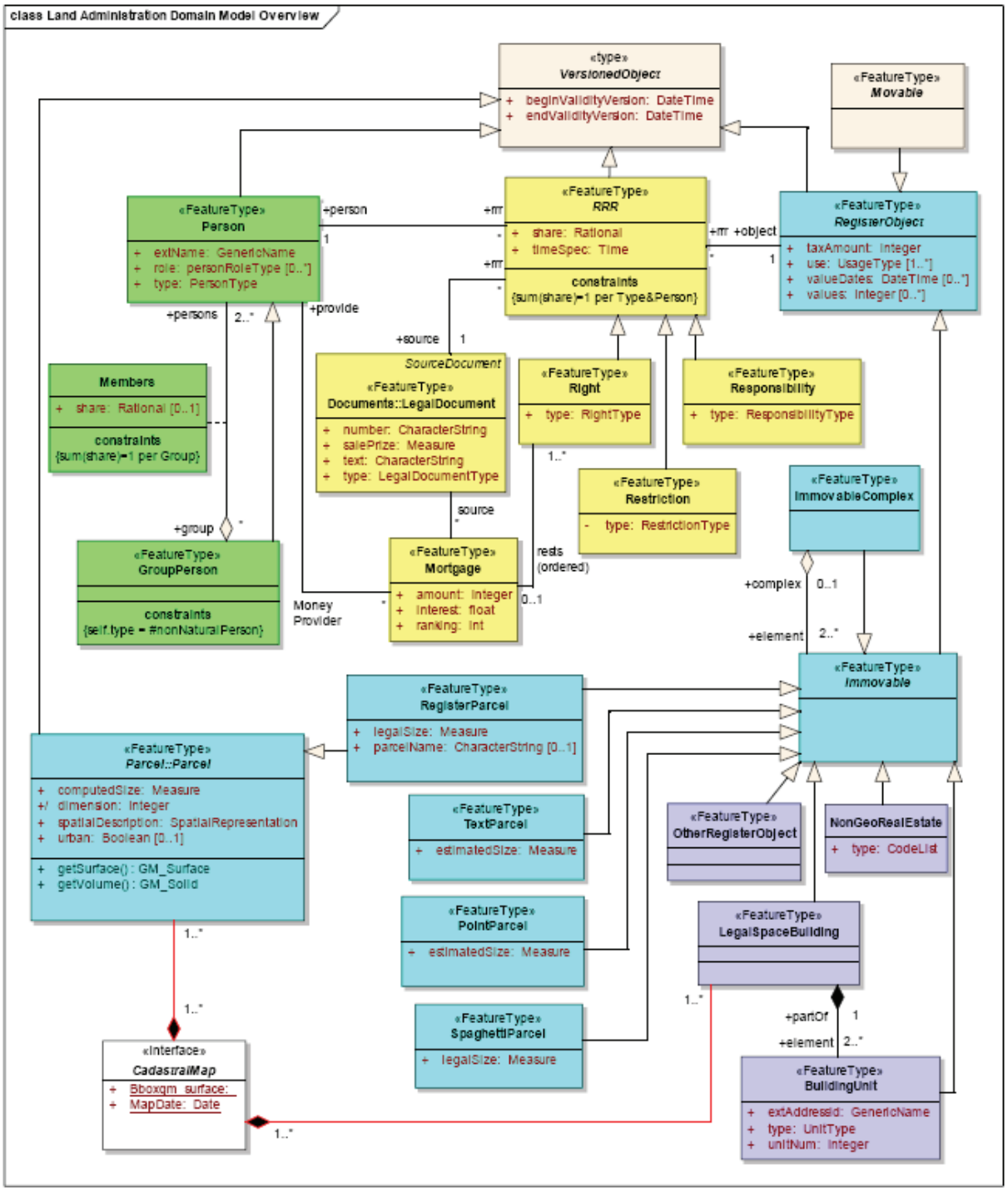

Figure 3. Registered objects (source: LADM Working Draft 1)

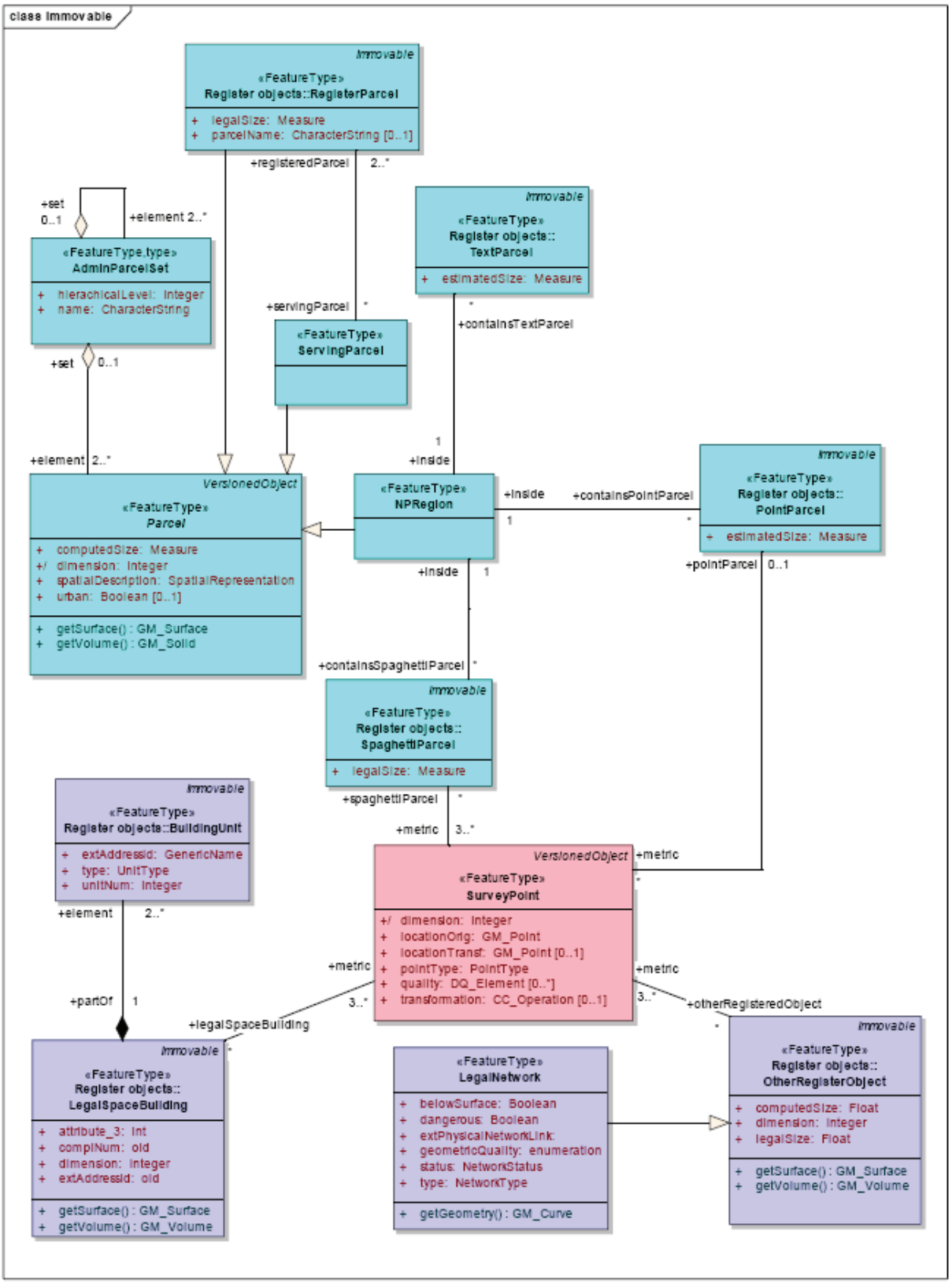

Figure 4. Parcels (source: LADM Working Draft 1)

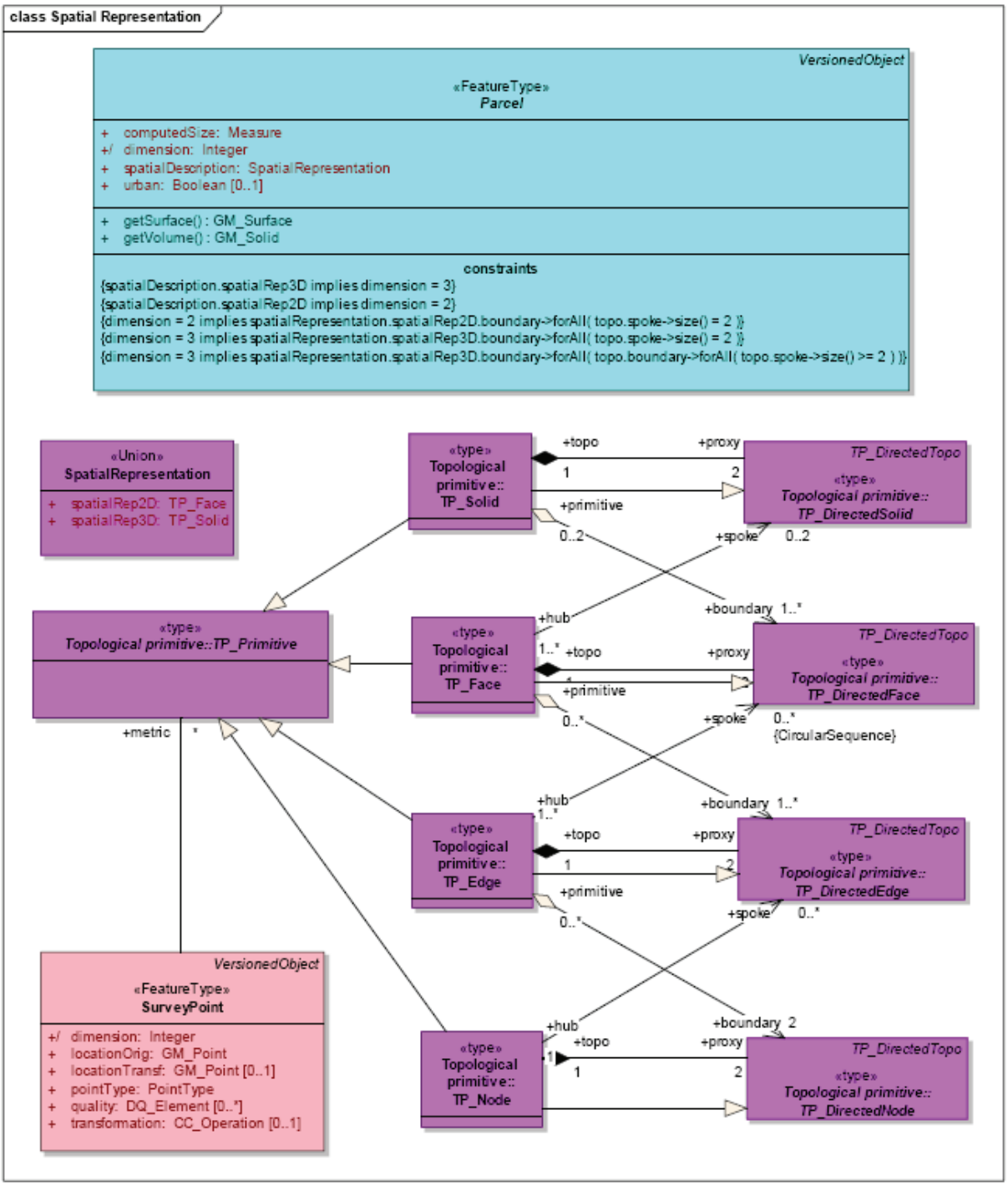

Figure 5. Spatial representation of parcels and survey points (source: LADM Working Draft 1)

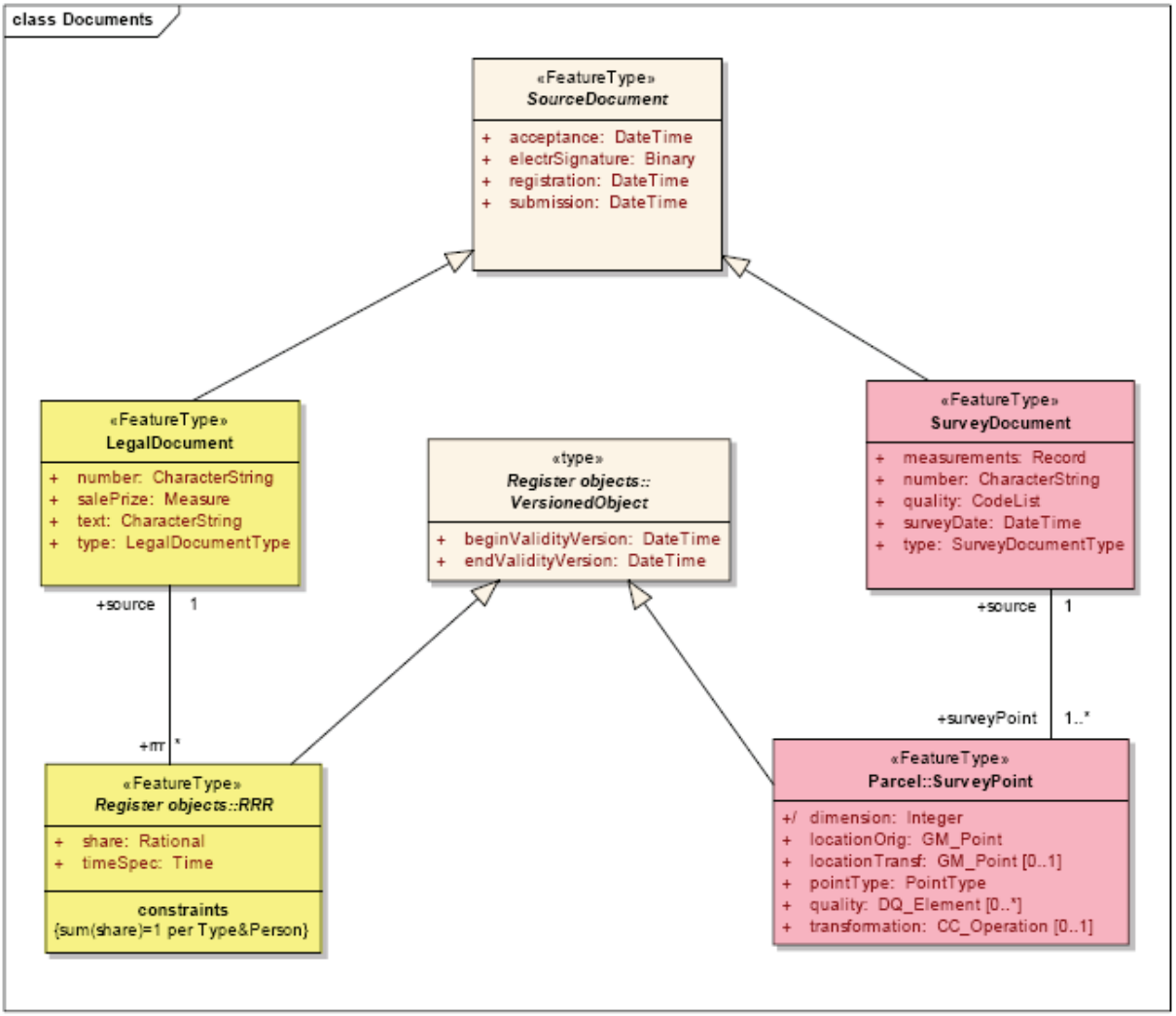

Figure 6. Documents (source: LADM Working Draft 1)

3.4.26. Interface object

The interface object is used to generate cadastral map and management of product and service. It does not have any attributes.

4. The Land Administration System in Indonesia

4.1. Introduction

This chapter is about the land administration system operational in Indonesia. This chapter includes the legal framework and current practice of land administration. The legal framework of land administration system in Indonesia is usually linked to the Basic Agrarian Law and its specific regulations. In addition, overview on share regulation and adat law are also included. Description of share regulation is intended to address the possibility of enhance women's access to land in Indonesia. Women share in property is acknowledged by legal framework but is not included into current practice of land registration. The adat law is the genuine law of Indonesian people and still become a precious norm in the society until now. UN-Habitat (2008) identified that women, indigenous peoples and marginalised groups continue to face discrimination on secure rights in many countries. Recognition of adat land and inclusion women as co-ownership can be a solution to cope with discrimination on secure land rights. If share information and adat land are included in the formal system, they will be a variable in land administration system.

4.2. Legal framework

The legislation in Indonesia is arranged in a hierarchy. The Decision of People Consultative Assembly (2000) defines the hierarchies of legislation in Indonesia as follows:

1. State Constitution (Undang – Undang Dasar 1945)
2. Decision of People Consultative Assembly (Ketetapan Majelis Permusyawaratan Rakyat)
3. Law (Undang – Undang)
4. Government Regulation Substituting Law (Peraturan Pemerintah Pengganti Undang - Undang)
5. Government Regulation (Peraturan Pemerintah)
6. Presidential Decree (Keputusan Presiden)
7. Regional Regulation (Peraturan Daerah)

As such, the legal framework on land administration is also arranged in hierarchy. The legal aspects related to the land administration system in Indonesia are described below.

4.2.1. The Basic Agrarian Law

The Land Administration System in Indonesia is ruled by law number 5/1960 or well known as Basic Agrarian Law (BAL). The main intensions of the Basic Agrarian Law are:

1. Put the foundation of arrangement the national agrarian law which will be a tool to bring wealth, happiness and justice
2. Put the foundation to unify and simplify land law.
3. Put the foundation to give tenure security to all citizens.

The Basic Agrarian Law was enacted to implement article 33 of Indonesian Constitution. The substance of article 33 was implemented on article 1 and article 2 in BAL. According to article 1; land, water and space including treasure adhere within Indonesian territory is given by God and considered as national treasure. The relationship between Indonesians and land, water and space is eternal. Article 2 stipulates that land, water and space, is governed by state as organization of all people. The right to govern means authority to:

1. Govern and operate allocation, use, supply and maintenance of land water and space.
2. Define and govern legal relationship between people with land, water and space
3. Define and govern legal relationship between people and legal actions about land, water and space.

Right of ulayat has a special place in BAL, which is article 3. It stipulates that the carry out of ulayat right (and similar rights from adat right society), as long as it still exists, should be in such a way that it is in conformance to the national and state interest, based on national unity and not in conflict to the other higher level of law.

In general, BAL relies on adat rights as stipulated in article 5. The valid agrarian law over land, water and space is adat law, as long as it is compatible to the national interest, based on national unity and Indonesian socialism, as well as on regulations stipulated in the BAL and other laws with regard to religion.

Referring to article 4, article 16 of the Basic Agrarian Law 8 land right types are defined: right of ownership (*Hak Milik*), right to cultivate land (*Hak Guna Usaha*), right to construct building (*Hak Guna Bangunan*), right of use (*Hak Pakai*), right of lease (*Hak Sewa*), right to open up land (*Hak Membuka Tanah*), right to pick up forest product (*Hak Memungut Hasil Hutan*), and other rights as mentioned in article 53; which are right of pledge (*Hak Sewa*), right of share cropping (*Hak Usaha Bagi Hasil*), right of lodging (*Hak Menumpang*) and right to lease agricultural land (*Hak Sewa Tanah Pertanian*). Among any others rights, right of ownership is the highest level of right. Eventhough BAL specifies 8 land right types, only 5 of them are implemented currently. *Hak Membuka Tanah*, *Hak Memungut Hasil Hutan*, *Hak Sewa*, *Hak Usaha Bagi Hasil*, *Hak Menumpang*, and *Hak Sewa Tanah Pertanian* are not yet implemented, mainly they are exists in customary tenure.

The land registration activity is introduced in article 19 of BAL. It mentions that government shall operate land registration to guarantee tenure security. The registration activities consists of survey for mapping and land booking, registration of land right and transfers, and providing certificate of right as strong evidence.

4.2.2. Laws and government regulations that support BAL

As mentioned before, The Basic Agrarian Law outlines main matters and basic principals only. The implementation should be broken down into other laws, government regulations and other legal decrees or regulations. Below some legal regulations are introduced pertaining with the Basic Agrarian Law.

4.2.2.1. Government Regulation Number 38/1963

This regulation is about assignment of legal bodies which can hold right of ownership (Hak Milik). This regulation defines four legal bodies:

1. State owned banks.
2. Association of agriculture cooperative (economic enterprise).
3. Religious body appointed by the minister of agriculture/agrarian after hearing the minister of religion.
4. Social body appointed by the minister of agriculture/agrarian after hearing the minister of social welfare.

In addition, this regulation defines the maximum area of land that can be owned by each body. This is one of the obstacles to recognise adat land – adat land cannot be owned based on this regulation.

4.2.2.2. Government Regulation Number 28/1977

Indonesian government acknowledges six religions. The six religions are Moslem, Catholic, Protestant, Hindu, Buddhist and KongHuCu. Islam is by far the main religion in Indonesia with roughly 80% of population being affiliated with it. Considering this large Islamic population, the Government of Indonesia enacted Government Regulation number 28/1977 known as waqf regulation.

According to the regulation, waqf is a legal action of a person or legal body to separate a part of their land and eternally institutionalize it for religious purpose or other purpose according to Islam. The Basic Agrarian Law did not define such a right explicitly, but stipulated that the government should create general plan about stock, allocation and use of land, water and space for religious activity.

4.2.2.3. Law Number 16/1985 and Government Regulation Number 04/1988

The Law number 16/1985 is known as Apartment Law. The law stipulates that an apartment unit is subject of immovable registration. The apartment can only be constructed above a right of ownership, right of building, right of use over state land, or state land. Government regulation number 04/1988 was enacted to provide detailed implementation rules of the apartment law. This legislation is the base for registration of building units (apartments).

4.2.2.4. Government Regulation Number 40/1996

This regulation regulates the right to cultivate land (*Hak Guna Usaha* in short *HGU*), the right to construct building (*Hak Guna Bangunan* in short *HGB*), and the right of use (*Hak Pakai* in short *HP*). The regulation includes the subject of rights, the duration of rights, the original rights, and the transfer of rights. The table below shows the characteristics of *HGU*, *HGB* and *HP*

Right Name	Subjects	Duration	Given Over:
HGU	▪ Indonesian Citizens ▪ Indonesian Legal Bodies located in Indonesia	35 years, can be extended for maximum 25 years more.	▪ State land.

HGB	▪ Indonesian Citizens ▪ Indonesian Legal Bodies located in Indonesia	30 years, can be extended for maximum 20 years more.	▪ State Land ▪ Right of Management ▪ Right of Ownership
HP	▪ Indonesian Citizens ▪ Indonesian Legal Bodies located in Indonesia ▪ Central Government and Local Government ▪ Religious and Social Body ▪ Foreigners who live in Indonesia ▪ Embassy and International Organization	25 years, can be extended for maximum 20 years. Can also be given for as long as still in use	▪ State land ▪ Right of Management ▪ Right of Ownership

Table 4. Characteristic of HGU, HGB and HP

All rights mentioned above can be subject of mortgage. Transfers applicable for those rights are trading, swapping, capital participation, grant, and inheritance.

In addition, this regulation also defines the right of management (*Hak Pengelolaan* in short *HPL*) as the state right to govern - for which the authority to implement is partly handed to the holder (the holder can be a government or a private company). However, this regulation did not define any other aspects such as subjects, durations, origin and transfers of *HPL*.

4.2.2.5. Government Regulation Number 24/1997

This regulation is known as the land registration regulation. It was enacted to compel government regulation number 10/1961, also about land registration. Both regulations refer to article 19 of the Basic Agrarian Law. According regulation 24/1997 the basic principle of land registration should simple, secure, affordable, up-to-date, and open as described in article 2. Article 3 stipulates that land registration aims to:

1. Ensure tenure security to the land right holder, apartment unit right holder and other rights in order to make it easy to prove their ownership.
2. Provide information to the interested parties including government in order to easily get required data to conduct legal action (e.g. transfer) about registered land and/or apartment unit.
3. Establish good land administration

The regulation mandated BPN as the only one government organization which conducts land registration. In order to perform land registration, BPN is assisted by *Pejabat Pembuat Akta Tanah (PPAT)*. The PPAT can be a notary appointed by BPN or head of sub-district in absence of notary in a particular area. Article 9 defines the objects of land registration: lands with the right of ownership, the right to cultivate land, the right of building, the right of use, the right of management, waqf land, apartment unit, mortgage, and state land. The regulation also defines the land registration unit. The registration unit basically is village except for right to cultivate land, mortgage and state land: in those cases the registration unit is district. The registration unit is interpreted as numbering system of parcels

and right is based on village or district depending on its unit. Article 11 stipulated land registration cover adjudication and maintenance land data. Working with different registration units for different types of right is proved to be not efficient.

Adjudication covers some activities as follows:

1. Collecting and processing of physical data – surveying the parcel boundary
2. Right verification in the field by adjudication committee and booking in the register.
3. Physical (map) and juridical data presentation – this is a public inspection where all cadastral data are published. There can be objections.
4. Certificate issuance.
5. Storing public register and document.

Adjudication in Indonesia may be conducted in sporadic adjudication or mass/systematic adjudication. Sporadic adjudication is mostly implemented voluntarily by citizens who want to register their land. Mass adjudication is commonly an obligatory process initiated by a decision of the chair of BPN, this decision includes the location of the adjudication area. The parcels covered by this adjudication area are then registered by the adjudication committee. The parcel boundaries should be accurately surveyed and the boundaries should be defined by interested parties (neighbours). Adverse possession is acknowledged by the regulation as stipulated in article 24. The period to claim a land by adverse possession is 20 years. In case of a piece of land is registered peacefully by a person or legal body and tangibly occupied for 5 year, other parties can not claim that ownership after those 5 years (article 32). Disputes on registered land are handled by the court. BPN will abrogate land rights or apartment rights base on court decisions as mentioned in article 55.

The land data maintenance covers two main activities:

1. Registration of transfer of all right types and establishment of encumbrances
2. Registration of other land changes; e.g. land subdivision, inheritance etc.

Maintenance of land registration data should be done in case of physical and juridical data changes on registered land. According to the regulation it is compulsory to register the changes. But in reality many people do not register because of formal and informal fees and taxation which has to be paid in relation to a transaction. The court decided that one can be owner even if the land is not registered. Land registration data changes include right transfer (trading, granting, swapping, capital participation, bidding, inheritance, and merger), extension of right, sub-division, and amalgamation.

4.2.2.6. Share regulation

Properties, including land rights, are subject of collective treasure within household. Identification of shares is importance to ensure women access to land. Currently, women are not included in land certificate as co-owner. In case of divorce, they often find difficulties to get their portion.

Share is not defined in any land administration law, but in Marriage Law, Civil Code. Article 36 of the marriage law rules that husband or wife can agree on an act over collective treasures on spouse agreement. It means that both husband and wife should agree on collective treasure transfer such as trading, grant, etc. Share on divorce is stipulated in the Marriage Law article 37. In case of divorce, the subdivision of the collective treasures is ruled by appropriate law; “appropriate law” refers to Civil

Code, Qur'an or even Adat Law, the choice depends on the preferences of the people. The preference of law is important because Indonesia has wide diversity in term of religion and adat. Mixed marriages often happen in this country. Civil code is applicable for people in general while Islamic law collection applicable only for peoples who affiliate with Islam and decide to use Islamic law. There are variations in the portions.

Article 128 of the Civil Code stipulates that collective treasure is divided into two among husband and wife, or among their inheritor regardless from where the treasures come from. In case of polygamy, in general article 181 can be applied; in case where a previous wife has children, the subsequent wives can not have share more than those children share. In case of children from previous wife pass away then subsequent wife can not have more than 1/4. The first wife and subsequent wives are entitled to share in all treasures after their marriage. On the other way, the second or subsequent wives do not be entitled to the treasures which are available from before their marriage. It should be noted here that only treasures gained after marriage are subject of share.

Islamic people may use Qur'an as a basis to share the treasures. Qur'an define people eligible as inheritor are husband, wife, son, daughter, sister, brother, mother, father, grandfather, grandmother, grandson, and granddaughter. The portion of share vary from 1/2, 1/4, 1/8, 2/3, 1/3, to 1/6 according to closeness to the heir. Wives can only get 1/4 or 1/8 portion from collective treasures. Wife will get 1/4 if her husband doesn't have children (an-Nisa': 12). In case her husband has children, the wife will get 1/8. It should be noted here that the portion of wife is distributed to all wife in case of polygamy.

4.2.3. The adat law

The adat law did exist on all the Indonesian islands before the area was colonized by the Dutch. The term of adat law (in Dutch 'Adat Recht') was introduced by Prof. Dr. Snouck Hurgronje in his book 'De Atjehers'. Adat Law became more famous since Prof. Dr. Cornellis Van Volenhoven introduced it as a science on October 3, 1901. Van Vollenhoven identified nineteen Adat Law circles as follows:

1. Aceh (Aceh Besar, Pantai Barat, Singkel, Simeulue).
2. Tanah Gayo (Gayo Lueus, Tanah Alas, Tanah Batak / Tapanuli).
3. Tanah Minangkabau (Padang, Agam, Tanah Datar, Limapuluh Kota, Tanah Kampar, Kerinci) and Mentawai (Orang Pagai).
4. Sumatera Selatan (Bengkulu, Lampung, Palembang, Jambi).
5. Tanah Melayu (Lingga-Riau, Indragiri, Sumatra Timur, Orang Banjar).
6. Bangka Belitung.
7. Kalimantan (Dayak, Kalimantan Barat, Kapuas Hulu, Kalimantan Tenggara, Mahakam Hulu, Pasir, Dayak Kenya, Dayak Klemanten, Dayak Landak, Dayak Tayan, Dayak Lawangan, Lepo Alim, Lepo Timai, Long Glatt, Dayak Maanyan Pantai, Dayak Maanyan Siung, Dayak Ngaju, Dayak Ot-Danum, Dayak Penyabung-Punan).
8. Minahasa (Menado).
9. Gorontalo (Bolaang Mangondow, Boalemo).
10. Tanah Toraja (Sulawesi Tengah, Toraja, Toraja Baree, Toraja Barat, Sigi, Kaili, Tawaii, Toraja Sadan, To Mori, To Lainang, Kepulauan Banggai).
11. Sulawesi Selatan (Orang Bugis, Bone, Gowa, Laikang, Ponre, Mandar, Makassar, Selayar, Muna).
12. Kepulauan Ternate (Ternate, Tidore, Halmahera, Tobelo, Kepulauan Sula).

13. Maluku-Ambon (Ambon, Hitu, Banda, Kepulauan Uliasar, Saparua, Buru, Seram, Kepulauan Kei, Kepulauan Aru, Kisar).
14. Irian.
15. Kepulauan Timor (Timor Timur, Timor Barat, Timor Tengah, Mollo, Sumba, Sumban Tengah, Sumba Timor, Kodi, Flores, Ngada, Roti, Savu, Bima).
16. Bali and Lombok (Bali, Tenganan Pagringsingan, Kastala, Karangasem, Buleleng, Jembrana, Lombok, Sumbawa).
17. Jawa Tengah, Jawa Timur and Madura (Jawa Tengah, Kedu, Purwokerto, Tulung Agung, Jawa Timur, Surabaya, Madura).
18. Daerah Swapraja (Solo and Yogyakarta).
19. Jawa Barat (Periangan, Sunda, Jakarta, Banten).

Adat Laws regulates various aspects of human life such as private law, family law, marriage law, marriage property law, inheritance law, land law, debit and credit law, criminal law and governmental law.

4.2.3.1. Land right in adat law

The existence of land right in adat law is strongly related to the existence of tribes in Indonesia. The tribes live in a particular area with a certain boundary and have sovereignty over their territory. Terminologies referring to territorial unit are: *Patuanan* in Ambon, *Panyampeto* or *Pawatasan* in Kalimantan, *Wewengkon* in Java, *Prabumian* in Bali, *Totabuan* in Bolaang Mangondow, *Limpo* in South Sulawesi, *Nuru* in Buru, *Ulayat* in Minangkabau, *Torluk* in Angkola, *Paer* in Lombok, and *Golat* in Batak.

Within the territory, adat law including land law is imposed to the tribe members. To give a uniform term for whole country, the right of ulayat is used to identify adat land right as mentioned in Basic Agrarian Law. Right of ulayat can be defined as community right over land within their territory. Characteristics of right of ulayat are (Setiady, 2008):

1. The adat community and its member reserve the right to use the land, and cropping everything above the land,
2. Individual right covered by community right,
3. The leader of community may define and declare the use of a particular land as common use. Individual right over common land is not allowed,
4. The outsiders who want to crop from ulayat land should hold permit from community leader and should pay some charge or give a gratuity in tribute,
5. The adat community takes responsibility to whatever transpires over ulayat land, and;
6. Both the community and its member can not make an absolute decision causing the community absolutely loosing control over ulayat land.

Object of ulayat can be land, water, tree and animal whose habitat is over ulayat land. In Minangkabau, ulayat land can be *ulayat land of nagari*, *ulayat land of tribe* or *ulayat land of family*. *Tanah ulayat nagari* are lands which belong to "*nagari*" territory, the management and distribution is held by *nagari* leader. *Nagari* is traditional community system in Minangkabau. *Tanah ulayat nagari* is usually in form of public facility or forest. Ulayat land of a tribe is occupied and managed by the tribe hereditary, the management is also held by tribe leader. The usage of ulayat land of the tribe

usually converted into ulayat land of family. All ulayat lands mentioned before are known as "*Tanah Pusaka Tinggi*". Beyond *Tanah Pusaka Tinggi*, there is "*Tanah Pusako Rendah*" which is the land received from somebody as gift, grant or developed/cultivated forest land. The communal land right is not only exists in Minangkabau. In Bali, communal land is known as "*Tanah Druwe*". "*Kintal Kalakeran*" refers to communal land in Manado.

Within communal land, individual rights are still reserved. Individual rights over ulayat land are:

1. Right of "occupation", the holder has full control over the land – so it works almost like ownership. In west java, this type of right is largely identified as *"Sawah Yasa"* or "*Sawah Milik"*. In Central Java, this type of right is named *"Sawah Yasan"* or *"Sawah Pusaka"*. According to the conversion terms in the Basic Agrarian Law (article 2), *Sawah Yasa*, *Sawah Milik*, *Sawah Yasan*, and *Sawah Pusaka* can be converted into right of ownership automatically. Right of "occupation" sometimes is given on top of communal land, for example *"Kanomeran"* in Ciamis, *"Kasikepan"* in Cirebon-Kuningan, *"Kacacahan"* in Majalengka, "S*awah Pakulen"* or "*Sawah Narawita"* in Central Java.
2. Right of cultivation/harvest, the holder may utilise the land or harvest the crops. In West Java, this type of right is known as "*Hak Memungut Huma*". *Hak Memungut Huma* only valid for one cultivating season only. *"Hak Menggarap"* in Cimanuk is also can be categorized into this type of right. In Java, village leader and village secretary is given the right to cultivate a land. It is widely known as "*Hak Memungut Hasil Karena Jabatan"*. A land with '*Hak Memungut Hasil Karena Jabatan"* is widely known as *Tanah Bengkok* in Java. In West Java, such lands are known as *"Tanah Carik"* or *"Tanah Kalungguhan"*. Right of cultivation/harvest is always given on top of right of occupation.
3. Right to transfer, including right to sell, right to grant, right to bequeath, and right to give away. Right to transfer is applicable for the right of "occupation" only. As opposite, there is also right to buy which can be given to families, other community members, or adjacent land owners.
4. Right of priority, is applicable if there are some parties have interest in a particular land. By interest means either interest to occupy, interest to buy, or interest to cultivate the land. In Dayak, right of priority is given to the people who place the boundary marks on a free land first. The land with boundary mark is known as *Pupuh* or *Siruan* in Dayak. Right of priority can be given to a person who cultivated a land at last. It is common in adat community that if a particular land haven't utilised anymore, the land right will be back to adat community. But a person who cultivates that land at last is given a right of priority. In Kalimantan, a land with right of priority is known as *Burukan*. Right of priority is also given to a person whose land adjacent to bush/shrub land. In South Sumatera, such lands are known as "*Ekor Tanah*" or "*Hapuan*".

All those kinds of adat land right address that adat land right is a high variable within land administration in Indonesia. The variations do exist even in one island. To give an introduction to the adat law in practice, land tenure system in Bali is described in section 4.2.3.2.

4.2.3.2. Tenure system in adat law (case from Bali)

Traditionally the land tenure system in Bali is strongly related to its social community structure. In Bali, "*Banjar"* and "*Desa Adat"* are the basic traditional governmental units with communal and

democratic spirit. Various families compose cooperative groups of neighbours bound called *Banjar* to assist one another in any field of work. Several *Banjar* are made up into a *Desa Adat*, at the centre of which are public facilities such as village market, meeting hall, drum tower, schools, public health centre are available. Despite of *Desa Adat (established by the community)*, "*Desa Dinas"* exists (established by the government) and refers to village administered by the central government. Village borders do not always overlap with the *Desa Adat* borders. They can encompass several *Desa Adat* and several *Banjar*. The head of the village, the "*Kepala Desa*", is responsible for ensuring that national and regional government decrees are implemented. In Bali, subject of adat land can be (Suartika, 2007):

1. *Desa Adat* Institution. *Desa Adat* Institution is a traditional government which governs a adat community. The adat institution may own two types of land are:
    - *"Tanah Desa"*, also known as "*Druwe Desa* " or "*Tanah Druwe"*. The land is managed and reserved for the common needs of its members. *Tanah Desa* is commonly used for cemetery, traditional market, meeting hall, *"Tanah Bukti"* which is cultivated land which harvests are awarded to the community leader. *Tanah Bukti* is similar to "*Tanah Bengkok"* in Java. *Tanah Desa* also takes the form of agricultural land, which is cultivated by sharecroppers who are members of *Desa Adat* institution. Harvests from this land are used to cover main expense of the community activities.
    - *"Tanah Laba Pura"* or *"Tanah Pelaba Pura"*, used for community temples and ancillary activities. In Indonesia, Bali is known as island of thousand temples. Every Desa Adat at least has three main temples: *"Puseh"* (central temple), *"Desa"* (village temple) and *"Dalem"* (cemetery temple) symbolizing the existence of trinity to create, preserve and destroy the world and all its creatures. Every temple has its own *Pelaba Pura* whose cultivation is organized by the priest. Two types of *Pelaba Pura* are *Pelaba Pura* that is used for the actual buildings of temple and *Pelaba Pura* whose harvest is utilised to support regular temple activities i.e. maintenance costs or recurrent ritual ceremonies.
2. Adat Member *("Krama Adat")*. Adat member may hold two types of land:
    - *"Tanah Pekarangan Desa"*. This type of adat land is given to the *"Krama Adat"* to build their houses. In some area such as Penglipuran, parcels have been arranged into similar size and have a regular orientation. In return the karma adat is obligated to provide *ayahan* and *patus* when required. *Ayahan* is a duty to provide voluntary physical labour while *patus* is a responsibility to provide materials in the form of coconut, oil, palm leaves, banana leaves, eggs, rice, bamboo, etc.

Figure 7. Panglipuran: a balinesse village

    - *"Tanah Ayahan Desa"*, can take form of wet or dry farm. Cultivation rights over this adat land are transferred to the *Krama Adat* who may subsequently harvest the land. In

return the *Desa Adat* members are obligated to provide *Desa Adat* with *ayahan* and *patus* when required.

Transferring adat land in Bali can't be done freely to other people. In principle, the land can only be transferred to people who affiliate with Hindu religion. This is because the people who occupy the land should provide *ayahan* and *patus* as mentioned before. The transfer also must get approval from *desa adat* members. The possible transfers are limited to inheritance, trading, swapping and grant. In case people don't have a family which is eligible to inherit the land, the right over adat land will be returned to *desa adat* and will be subject to distribution to other adat members. People who do not utilize the land may also loose their right. This term is very good to ensure the productivity of land, to ensure there are no vacuum lands.

Within adat law in Bali, there is no women-headed household. Adat members (*krama adat*) are always represented by a man. As such, the land right is always given to men. In case where a husband passes away, his position is replaced by his son. In case of a household do not has son, their membership is transferred to the nearest inheritor.

4.2.3.3. Share in adat law

Base on adat law, wife is not a beneficiary. The position of widow is different depending on family relationship as described below:

1. In Minangkabau where family relationship is Matrilineal, the marriage treasures will fall to the husband family. It is because the husband still belong to his mother's family so then his treasures must be back to his family.
2. In Tapanuli or Bali where family relationship is Patrilineal, the widow is acknowledged as part of her husband's family. The widows indeed remain as family of her husband and still deserve to earn money from her husband treasures for her lifetime. However, in case of divorce the women will be back to her origin family and often get no share.
3. In Java where family relationship is Paternalistic, widow is also not an inheritor but still deserves to earn money from her husband treasures.

Adat law stands on principle that wife is an externalist, so she does not inheritor but deserve to earn money from collective treasures for a lifetime. (Setiady, 2008) wrote that widow has different position to the inheritor.

4.3. Current condition of land administration in Indonesia

Discussion about current condition of land administration in Indonesia covers general overview of land administration, decentralization issue, possibilities to expand land administration scope, and some good practice in Indonesia.

4.3.1. General overview

Land registration in Indonesia does not only intend to provide security of tenure, but it is also used as basis to use ownership as collateral to get credit from bank. Land with a certificate of land usually has better value compared to non-registered parcels. However, land registration in Indonesia does not

guarantee security of tenure. The court has the right to expropriate land right and there is no guarantee for the right holder to get compensation of loosing land right. Nevertheless, the integrity of the system is sufficient for land owners to have full confidence in their rights if the land data is accurate (Erna H and Grant C, 2004).

Considering land right transfer, Indonesia operates a formal system and an informal system. The informal system refers to land right transfer without register it in a public list. Both systems are legal under Indonesian Law. Informal system may be operated on both un-registered parcels and registered parcels. Registered parcel may enter informal system through transfer process e.g. trading, when the buyer does not register the transfer to BPN. The opposite, the formal system is land right transfer with subsequent process of register the transfer to BPN. The formal system can only be operated on registered parcels. This process is encouraged because give better security to the successor owner. The reluctance of people to register the land mostly is caused by the lengthy process of registration and high costs. Informal fee is one of high cost cause. The other cost component is land right and building achievement tax (*Bea Perolehan Hak Atas Tanah dan Bangunan* in short BPHTB). BPHTB calculated by 5% of the parcel value, which can be really unaffordable by the poor especially in urban area where the land value is very expensive.

Land disputes are another problematic issue in Indonesia. The number of land disputes reaches 7491 cases on 2007. According to deputy of Investigation and Land Dispute of BPN, 85% cases identified as falsification and the rest is land grabbing (detikNews, 2008). Disputes do not only reduces land productivity but also damages social relationship among interested parties and are costly.

Currently, BPN acknowledges eight types of rights in land registration: *Hak Milik*, *Hak Guna Usaha*, *Hak Guna Bangunan*, *Hak Pakai*, *Hak Pengelolaan*, *Hak Wakaf*, *Hak Tanggungan*, and *Hak Milik Atas Satuan Rumah Susun*. The first four types of right are ruled by Basic Agrarian Law. The numbering system of title consists of a three block character. The first block character is the administration code, the second block is the right code, and the third is the right sequence. Similar to the title numbering system, the parcel numbering system consists of two block character. The first block character is the administration code and the second is the parcel sequence number. The problem arose when changes on administration code take place. Administration code is defined by the ministry of home affairs. In case of administration enlargement, the administration code usually changed as well. A database designer must be aware of it. Title number and parcel number should not be a primary key because they might be changed over time.

Geodetic controls do not cover whole country. BPN is charged to establish geodetic control order two, three and four. Geodetic control order zero and one is National Mapping Agency (*Badan Koordinasi Survey dan Pemetaan Nasional*) responsibility. The lack of geodetic control availability adversely affect cadastral mapping since no reference can be found to unify cadastral map among local office to build national land information system.

Reconstruction of cadastral boundaries in case of disputes relies on field sketch (*Gambar Ukur*). The *Gambar Ukur* represents measurement data, parcel boundary and other information related to parcel. For the information system, the cadastral index map is created from various sources. The cadastral index map represents parcel boundaries, street, river, building and often building. The main problem of creating cadastral map is consistency of data. The data entry project of cadastral data in Jakarta

province shows that almost 60% of parcels plotted in cadastral index map do not match to the textual registration data. Validation data in deed need to be done to provide better accuracy data.

Introduction of computers to store cadastral data started from 1998. In general, textual information and graphical information was physically separated. Textual information was stored in database management system either desktop database or client server architecture. Some offices tried to automate office duties by combined database with word processor to print certificate and generate monthly report. In order to deal with graphical data, most of the local offices make use of CAD program to draw cadastral map. The problem arose when the file size become larger and larger. Often, mapping staff split the file and work on several file to keep faster performance. As the result, there are duplications in data-files in one area.

4.3.2. Decentralization issue

(Rieger et al., 2001) identified some attempts to implement decentralization system throughout the history of Indonesia:

1. The first decentralization law, before its independence as a nation, introduced by the Verenigde Oost-Indische Company (VOC) as the first modern state on the territory was promulgated until 1903. It was the basis to establish districts. It did not change a lot in administrative practice, as the real centralism was colonial rule which was of a highly undemocratic nature.
2. The second was introduced in 1948, during transfer of sovereignty from Dutch to Indonesia as independent nation. There was an effort to alter the nation shape into federal state. The effort was perceived as a trick to weakening Republic of Indonesia by a *divide et impera* strategy. In 1948 government of Indonesia promulgated law number 22/1948 which had been mere levels of administrative hierarchy into autonomous regions. The federation state terminated in 1957 by presidential decree. The decree stated that constitution returned back to constitution 1945 which means centralised government. In 1974, the major decentralization law was promulgated which is law number 5/1974 about basic governance in the local government. However it never saw much implementation because the backlog in supporting regulations was never overcome by new order regime.
3. The latest decentralization effort, started from 1999 through bloody student movement in 1998 that contributed to the ouster of President Soeharto. Decentralization in this context means (Rieger et al., 2001):
    a. A more real say of people in running their daily affairs, because their choices matter for their immediate environment
    b. Policies better adapted to local aspirations instead of every region being put into the straightjacket of uniform national solutions
    c. More accountability of the administration, as decision makers can be watched more closely by the electorate
    d. The chance of using local resources for local development, instead of having them siphoned off by the centre.

Even though the latest decentralization was supported by the most conducive political environment, the implementation is still slow. Political will to decentralize land administration system after the fall of the new order regime under President Soeharto emerged at Law number 22/1999 (UU 22/1999). It

stipulates that land governance is subject of decentralization. Since the term of land governance perceived as ambiguous term, the polemic arose weather land registration and cadastre are under local government or not. Until government regulation number 25/2000 was under implementation, the central government tried to stop the polemic by declaring that the role of local government was limited outside land registration and cadastre. Subsequently, Presidential Decree number 34/2003 stipulates that the nine land-related governmental issues that are transferred to local government are:

1. Issuance of location permit,
2. Procurement of land for physical development purpose,
3. Land dispute resolution for leasing land (*tanah garapan*),
4. Resolution of land compensation problem for development,
5. Determination of subject and object of land redistribution, as well as compensation for absentee land,
6. Determination and resolving problem related to right of ulayat,
7. The use and disposal of vacuum land issues,
8. Giving permission to open up land, and;
9. Land use planning.

The presidential decree also mandated BPN to accelerate:

1. Preparation of Basic Agrarian Law completion draft and other laws related to land governance.
2. Development of National Land Information System that covers:
    - Textual and spatial database for government assets in the whole country
    - Preparation of textual and spatial application for land registration as well as creation of land ownership and land occupancy databases that is linked to e-government, e-commerce and e-payment, cadastral mapping for inventory and registration of occupancy, ownership, use, as well as utilization of land by make use of satellite imagery to support land reform and land right granting.
    - Development and elaboration land use management through land information system by prioritizing determination of irrigated farms in order to maintain food security.

Given those tasks, some local offices complained about the transferred small portion of land governance to local government – without giving the most expected governance which is land registration and cadastral governance. Then the, House of Representative promulgated law number 32/2004 that stipulates that and administration shall be carried out by local government. However the implementation was postponed until now, waiting for the specific regulation about transferring equipment, human resources, and archives. The long road of implementation of decentralization on land administration system seems still to be passed by.

4.3.3. Some possibilities to expand land registration scopes

This section describes some aspects that are not yet well managed in the current system. Those aspects including recognition of adat land, women's access to land, and environmental protection.

4.3.3.1. Recognition of adat land

The Basic Agrarian Law was enacted to accommodate adat law to build the unity in law. However, currently adat land has never been recognized within the formal system. Arguments to include adat land into the formal system are:

1. Provide better security tenure on adat land,
2. Provide document that can be used as collateral,
3. Empowering indigenous people and acknowledge their participation on national development, and;
4. Ensure sustainability in development as most of the indigenous people live in the forest area and most of them defend the forest as religious place.

In order to give a better description about obstacles to include adat land into formal system, a case from Bali can be one example. In Bali, Tanah adat might be owned by *Desa Adat* or *Desa Adat* member. Tanah adat owned by *Desa Adat* can not be registered because according to Government Regulation 38/1963 is not acknowledged as legal body to own the land. This regulation determines four legal bodies as land owner: banks, agriculture economic enterprises (*koperasi pertanian*), religious institutions appointed by Department of Religion and social institutions appointed by the Department of Social. A case from Klungkung District in Bali can be presented here. Banjar Togoh A is part of Desa Adat Tohpati in Klungkung district. BPN Klungkung which is mandated to conduct land registration refuses to register a cemetery claimed by Banjar Togoh A. The formal reason is because it violates Basic Agrarian Law which is implemented by government regulation 38/1963 (Balipost, 2008).

The recognition of adat land however should be done carefully by identifying characteristics of each adat law within the country. The recognition can freeze customary law that is in place at the time. For example, the right to transfer customary right may need to be restricted. The mortgage system on adat land may be need to be arranged in such away that in case the creditor failed to pay the interest, the land does not transferred to improper party.

4.3.3.2. Women's access to land

The tremendous economic pressure in Indonesia forced household head to be a migrant labourer. This situation increases the number of women becoming household head. Another family structure change such as death, divorce, abandonment and disability may also force the women to become household head. When the heads of household is no longer available to drive their traditional roles, the remaining household must be able to have appropriate economic resources to support their live. Land is considered as the employment provider, especially in the rural areas. Despite of the role as employment provider, land also provides the basic needs of life which is shelter. In urban area, land can be a precious treasury and often symbolize the social status and power of the owner. Thus, access to the land is the key to support household welfare.

Women are one of the vulnerable groups in Indonesia. They have less voice within the community, and less security. It often happens that women enjoy something at the good will of her male relatives. Single, widowed and divorced women can ultimately be dependent on the good will of their distance family. Improving gender access to land may improve economic and social disadvantages. The gender

term is used to notify that women are not only one party who should be protected. In the society with matrilineal system, men may suffer from disadvantage of social structure change.

The article published in Kompas, the biggest newspaper in Indonesia, on 9 September 2008 represents woman condition in general. The article (Kompas, 2008) reported about women condition in Nusa Tenggara Barat (NTB) province. The numbers of widows in NTB reach 16.5%. Roughly 45-46% of them became widow because of their husband passed away, 21% by divorce and 21% was left by their husband irresponsibly. From education perspective, 50-52% didn't graduate from elementary school, 11.60% graduated from elementary school, 15.23% graduated from secondary high school. In deed, they do not have skills to survive. The tragic situation of NTB women strongly related to the family culture which put women as man's dependant. In case of divorce, their husband hand their children to women. A Social observer from University of Mataram complained about less attention from government to them.

In land administration field, access to land may be implemented by recording husband and wife as land right holder or co-ownership.

4.3.3.3. Environmental protection

There are a number of environmental pollution cases caused by big company. One of the big cases might be case in Toba Lake, North Sumatera. Toba Lake was adversely affected by progressive deforestation conducted by a pulp factory. The company, which operates the factory, cut the forest to change the tree with eucalyptus. Another pig breeding company throws animal waste to the lake (Batak Pos, 2008). Of course land administration can not solely solve those problems but it can help a lot by imposing responsibility to protect environment quality surround the land, especially natural resources. Current land administration system includes responsibility to protect environment quality over parcel where the right issued only, not surround it.

4.3.4. Some good practices related to land registration in Indonesia

In order to provides better security of tenure and transparency process, BPN has initiated some activities such as building standards, accelerating land registration, reducing contact among citizen and BPN employee, and converting land archive into digital format.

4.3.4.1. Building standards

The Standard Operation Procedure (SPOPP) was released on 2006. This standard consists of service kind, legal foundation, pre-requirement, work-flow, time limit to process particular land service, and service fee. The SPOPP aimed to enhance public service on land registration, transparency, responsibility form of government to the public, reduce collusion, corruption and nepotism (Kolusi, Korupsi, Nepotisme in short KKN), and product guarantee. Another standard is spatial data standard. Spatial standard limited to layer and entity standard only in DXF format. The DXF format was chosen because in fact most of BPN Surveyor / Mapping staff familiar with CAD software. Contrast with their knowledge to operate the software, the product was not in the same quality. Spatial data standard aimed to define what entity should be in a specific layer and how to validate the spatial data.

Validation was conducted by check the data again topology rule. On going activity is to define data flow and database structure for whole country. This is the room where LADM may get involve.

4.3.4.2. Accelerating land registration

One of the major issues on land registration in Indonesia is the number of unregistered parcels. Completing the cadastral map coverage in Indonesia is really a big challenge. Some factor need to be considered such as budget, human resources, and organization arrangement. With existing resources and procedures, (Heryani and Grant, 2004) estimate Indonesia need 100 years to complete land registration. (Williamson, 2000) wrote that appropriate solution matched to the stage of development and specific requirement need to be defined to accelerate land registration. For example, if Indonesia whished to have a land administration system supported by a land titling and cadastral surveying system similar to Australia, it may need 40.000 professional surveyors and 30 or more university programs educating professional surveyor. The use of innovative spatial data acquisition methods must be considered to accelerate land registration process.

Currently, land registration in Indonesia covers 37.5 million registered parcels from estimated total of 85 million parcels or equal to 44% (Bappenas, 2007). Compare to other countries in South East Asia, the number of registered parcel relatively low. According to (World Bank, 2005), in 2005 registered parcels in Thailand reached almost 80% and Philippines reached almost 60%. The main advantages of having complete cadastral map:

1. Better security tenure,
2. Useful for taxation and multipurpose cadastre in general,
3. Ensure fair land taxation and transparent revenue sharing between central and local government,
4. Avoid double certificate issuance,
5. Provide important information for land use management and planning, and;
6. Support emergency response.

In 1991, the World Bank recommended a long term program to emergence an efficient land market and alleviating social conflict over land right. The Land Administration Project (LAP) was implemented on 1994 and in general it improve social and economic status of more than 1.8 million households through security tenure to land and property (Heryani and Grant, 2004). Following the LAP, Land Management and Policy Development Project was established on 2004. The project aimed to issue 5 million titles. The highest target is planned on 2008 to register 5.4 million parcels. About 1.4 million out of 5.4 million is allocated for the poor (Badan Pertanahan Nasional, 2008a). The target will be achieved through land reform initiative.

4.3.4.3. Reducing contact with BPN employee

An effort to provide transparent process in land registration has taken place by introducing a kiosk terminal that is positioned at the queuing room of some local offices. With a kiosk terminal, citizen can obtain their registration process status, workflow procedure, and registration cost (including boundary survey cost). The idea to provide kiosk terminal is a good starting point to reduce contact between citizen and BPN employee.

4.3.4.4. Converting land archive into digital format

Taking experience from disastrous Tsunami in Aceh, Central BPN tried to digitalize land archive in some land offices such as Jakarta Province, Bogor District, Bogor Municipal, Semarang and Malang District. Archive digitalization is very important in case of natural disaster. In fact, Indonesia in general is threatened by some natural disaster such as earth quake, volcano, tsunami and flood.

5. Analysis of user requirements

5.1. Introduction

This chapter describes about the requirements from internal and external users. The requirements are collected during fieldwork through questionnaires and interviews. The main respondents are citizens, local offices employees and employees from the Centre for Data and Information System department (from BPN). The user requirements are analysed if they fit on the LADM possibilities.

5.2. Basic parcel information

Requirement Description

In general, people perceived that the following information about land is important:

1. Title number: in title number, there is a number indicate the right type (see section 4.3.1). Hak milik is the strongest right. It doesn't need renewal, while HGB need renewal. Every renewal is subject of tax by 5% of land value. Apparently peoples avoid Hak Guna Bangunan. For time-limited right such as HGB, people usually ask the expiration date of the right.
2. Parcel area: is very important information perceived by people. This is the first question asked by people who wants to buy a piece of land. The area of parcel is one factor for calculating land price and tax.
3. Parcel value: everybody who gets a new right including adjudication, trading, inheritance, splitting or amalgamation is subject to taxation. Receivement of tax payment is one of the prerequisite documents on submitting the application of registration. However, BPN does not provide parcel value data so people need to go to directorate PBB to get information. This is a shortcoming of the separation between fiscal and legal cadastre. In absence of integrated information system, additional cost is needed to travel to other agency and also time consuming.
4. Land use is perceived as less important by people. It is because in case of buying, people prefer to visit the location and see the real land use. The information recorded in certificate or database is often obsolete. It is merely land use when the parcel was adjudicated, and never maintained actively to reflect the changes on the ground. In addition, generally people are interested to know the regional planning that affects a particular parcel. Road planning, canal planning, or green belt are most important information for the people. Like land value, such information is also not available in BPN.
5. Dispute information: in case of dispute, BPN writes a remark in the land book, or sometimes on the cadastral maps. This manner does not allow other parties to be aware of it. The certificate which is hold by the owner does not contain such information. In case of the land is sold, the new owner may suffer a loss. The state does not guarantee the buyer rights. The buyer often checks the dispute prior to the transaction.
6. Land owner: private conveyance often occurs in Indonesia. It is not an illegal transaction, but an informal one. In an informal transaction, the last owner is not as it is written in the

certificate of land. The buyer often checks the validity of the owner at the BPN before a transaction take place.

Requirement Analysis
Basic parcel information needed by users such as title number, parcel area, parcel value, land use and land owner is provided by LADM. It should be noted here that within LADM area of parcel may come from legal area or calculated area. Legal area should be selected for information to the public, while calculated area can be used internally to assess cadastral map accuracy. Dispute information can be included in the Right class. Physical planning is also not provided, but this information is beyond land administration domain. Such information can be included from other department by enabling data sharing. On the other hand, public restrictions like green belt, sanctuary, historical sites can be provided by restriction class.

5.3. Providing security tenure

Requirement Description
Lidya has unregistered land. She expects to register her land to ensure security tenure, but she doesn't know how to register it to BPN. Having land without registration at BPN, she is worried about the boundary conflict with her neighbours. A conflict with neighbours is not only expensive in terms of cost, but also deprives her of the pleasance to live on her land. Even though she knows that the state does not guarantee the loss, she is comfortable with it because she believes that she is the right owner of her land.

Widodo and Rahmi also expect security tenure from land registration. He bought a house from a house developer recently. He doesn't worry a about boundary conflict because the developer offered a permanent fence around his house. However he is worried about losing his land if he doesn't have the land certificate in hand. Her friends experienced of didn't get land certificate until they completed loan payments in the bank.

Requirement Analysis
In order to provide security tenure, land administration system should be able to provide trusted information that is needed to prove ownership and reconstruct boundary. Building a land database will help organization that operates land administration to manage myriad land data and provide timely land information including information about ownership and parcel boundary. LADM is a conceptual model that can be transformed into spatial database to manage land data. LADM provide LegalDocument class to keep ownership evidences and SurveyDocument to keep cadastral field measurements. Cadastral field measurement is used to reconstruct boundary in case of dispute or disaster. Precise cadastral map can be stored in topology data model, to ensure that there are no gap and overlapping among parcels. The validity of legal and survey document as well as parcel boundary is managed by versioned object. It means that one can trace back previous state of those data.

5.4. Support mortgage security

Requirement Description

Alvin just bought land in East Jakarta. Unlike the other people, he wants to use his land as fish pond. Currently he is submitting an application to register his land. His intention to register the land is to get a loan from the bank to support his fish pond operation. He knows the procedure, the prerequisite documents from his friend in BPN. He prefers to put his land certificate as collateral in Bank rather than keep it at home. However he still has some doubt whether his mortgage application will be accepted or not.

Ardian, S has a different story. He bought a house from a housing developer. According to the buying contract, the developer is responsible for submitting registration to BPN as well as arranging the mortgage application. However, he does not know the progress of registration while he pays the loan interest monthly. The combination of land registration and mortgage held by housing developer is often not transparent. Some citizens complain about this un-transparency and lengthy process (http://suarapembaca.detik.com, search with 'sertifikat tanah' keyword). One citizen even complains that he completed the mortgage already but he still does not get his certificate.

Requirement Analysis

It is very important for the bank as mortgage provider to be confident that all information of the collateral is valid. In Indonesia, land information including ownership, right type, land value, land area, and expiration date is important source to define mortgage value and term. Such information can only be obtained through good recording and good data management. This is the area where LADM can help mortgage security. All land information that is required to define mortgage value is provided. Furthermore, Indonesia recognizes mortgage rank system. It means that one property can be used as collateral in more than one credit as long as mortgage provider confidence on it. The important information for such system is the current total amount of mortgage. LADM support this system. Mortgage class has one-to-many relationship to right and it has a field named rank to keep ranking order information.

5.5. Easy land information access for citizen

Requirement Description

Easy of access information really matters in a big city like Jakarta. People who work in Jakarta may live in adjacent cities such as Bogor, Tangerang, Bekasi, or Depok. To register the land within office hours might conflict with their daily job. Muchtady is one example. He is heir of a piece of land from his father last year, but his daily job does not allow him to come to the local office in Tangerang. During interview, he mentioned that he knows the procedure to register his land but he does not know the amount of tax that he must pay.

Generally speaking, Muchtady maybe represents other citizens in Jakarta. In line with better IT infrastructure in Jakarta, people expect to get easy access to land data. The expectation of people can be found at one of the most favourite internet forums for Indonesia which is '*detik forum*' entitled "*Kenapa Sertifikat Tanah Tidak Online?*" meaning "why land certificate is not online?"(DetikForum,

2008). Some suspect that BPN is not willing to provide such easiness because BPN employees gain informal money from complicated processes. Some even voice their experiences with huge informal payment without having land certificate at the end.

One of notaries in Central Jakarta also pointed out the importance of easy access. He often checks validity of land certificate to BPN. However, he often gets disappointed because the BPN employee is not there when he comes to the office. He stated that if land data is accessible through internet, it will help him much. Transportation cost and informal cost are two factors that can be reduced.

Requirement Analysis
Through LADM, land information access indeed can be made easier because it is in a digital environment. Enabling land information access over internet is one choice to make easy access. Cadastral data can be published by utilising Web Services. Local offices that are located in the poor internet connection can provide Kiosk machine. It will reduce contact between citizens or notary and BPN employee and at the end is expected to reduce informal fee.

Enabling land information over internet is not an absurd idea for Indonesia. According to Internet World Stats (2008), Indonesia is one of the top twenty countries with the highest number of internet users. Total number of internet users in Indonesia is reported as 25 million. It contributes to 1.7% of the internet world users with user growth from 2000-2008 reaching 1,225.0%.

5.6. Affordable fee

Requirement Description
Sutiyono and Sudarman have unregistered land in South Jakarta. Both of them do not want to register the land due to some reason. Sutiyono said that the price for registering land is unaffordable while Sudarman said that he does not need credits from a bank so he decides not to register. They merely rely on the transfer deed as evidence of ownership. Both of them perceived ‘this half security’ by relying on the transfer deed, but they don’t mind with that situation because they occupy the land physically. However, they stated that if the registration process is affordable, they are willing to register their land voluntarily.

Irawan, D faces the same situation. Currently he owns land in Tangerang and is waiting for the mass adjudication in his village. He perceived that mass adjudication is better than sporadic adjudication in terms of completing time to finish registration and price. Unfortunately, his village is out of mass adjudication activity, so he leaves his parcel unregistered.

Requirement Analysis
In a sporadic adjudication fee component to register land are submission fee, land measurement fee and land right and building acquisition fee (*Bea Perolehan Hak atas Tanah dan Bangunan* in short *BPHTB*). The submission fee is Rp. 25.000,-. It is flat for every local office in Indonesia. Measurement fee is varying based on transportation cost in a particular region and parcel area. In Central Jakarta municipal, measurement fee for parcel with area of 500 m^2 is Rp. 199.600,- (transportation fee is not included, not very expensive). BPHTB is the highest cost in this area. It is calculated by 5% of

(property price minus Rp. 60,000,000 which is tax-free in Central Jakarta). If the property value is Rp. 500.000.000,- then the BPHTB is Rp. 22.000.000,-. For the poor, 22 million is really a big amount. The poor usually get the land by inheritance. As a result, they will leave their land unregistered. If they decide to sell their land, they will find that the price of unregistered parcel in Jakarta is lower than land with certificate. The poor also can not bank loan even though they have capital in form of land. BPHTB policy indeed should be reviewed, since by the time a parcel is adjudicated there is no transaction take place. At least, the poor should be released from obligation to pay BPHTB.

As mentioned before, informal fee also contributes to high of registration fee. There are no notaries willing to answer question about actual fee that they charge to the citizen. Implementation of LADM may able to reduce informal fee, especially if the contact between citizens or notaries and BPN employee can be reduced.

5.7. Recognition of customary land

Requirement Description

Sucana, G just bought a piece of *tanah pekarangan desa* (see section 4.2.3.2) in Klungkung district, Bali. He bought it from his family. The transaction took quite a long time because he needs to make sure that there are no complaints from the family of the seller who live on a different island. According to Indonesian law, *tanah pekarangan desa* can not be registered in BPN. The only evidence is a deed which is known by the elder and some witnesses. He perceived this is less secure. He is worried that somebody may claim the land and than suffer from a conflict among families. He is not the only one who wants to register the adat land. People in Bali in general expect that adat can be registered (Kompas, 2004). The desa adat community in Bali feels that they are marginalized by government, and are not even acknowledged as tax subjects by directorate of Land and Building Tax. Referring to the contribution of Balinese culture to attract tourism, they question about the fairness of government this regulation. While Balinese culture contributes a lot to the government revenue, their right is ignored and even violated.

Requirement Analysis

Basically LADM supports customary right. In fact, the basic concept of a relation between person – parcel is still valid for customary right. From LADM perspective, the only thing that is needed to accommodate customary right is add the type of customary right into the code list table RightType. The holder of this right, usually a tribe, can be put either in groupperson or person.

However, the challenge of recognition customary law goes beyond the technical part. The main problem is whether customary right will be converted to statutory right or just recorded as it is. West Sumatera province established a local government regulation about ulayat land and its utilization (*Peraturan Daerah Propinsi Sumatera Barat tentang Hak Ulayat dan Pemanfaatannya*). According to the regulation, *tanah ulayat nagari* (see section 4.2.3.1) can be converted into *Hak Guna Usaha, Hak Pakai* or *Hak Pengelolaan* (see section 4.2.2.4). *Nagari* leader (*Ninik Mamak Kerapatan Adat Nagari*) is proposed as the owner of *tanah ulayat nagari*. *Tanah ulayat suku* can be converted as *Hak Milik* and the holder can be awarded to tribe leader. *Tanah ulayat kaum* can be converted to *Hak Milik* and the oldest son in a family is registered as owner. If customary right should be converted into customary

right, most likely Bali needs a different treatment, since Balinese perceive that Hak Pakai deprive *Desa Adat* (see section 4.2.3.2) right over adat land. The better solution is adat land registered as *Hak Milik* with *Desa Adat* as the owner. *Tanah Pekarangan Desa* and *Tanah Ayahan Desa* (see section 4.2.3.2) can be given *Hak Pakai* on top of *Hak Milik* that is awarded to *Desa Adat* (form of superficies). This manner gives *Desa Adat* a full control to their adat land, and similar to their current customary tenure system. The later is also supported by LADM, because the RegisteredObject – RRR is a one-to-many relationship. It means that one registered object can have more than one right. For this scenario, government need to adapt Government Regulation number 38/1963 to allow *Desa Adat* as *Hak Milik* holder. In both cases, conversion from customary right to statutory right may advantage from simplicity of land law. However, the characteristic of customary right may be lost. For example, if customary law is converted to statutory law, it can be used as collateral to access bank loan. In case of failing to pay interest, the land can be handed over to other parties outside the tribes. On the other hand, recording customary right as it is help to preserve the characteristic of customary land. The drawback is the complexity of the system. Decentralization of Land Administration System might be suitable to cope with this complexity.

5.8. Improve land administration service

Requirement Description

Maryono wants to get better service in land administration. He experienced a cumbersome service, and spent much money and time when registering his land. The same thing is also experienced by Olive. In addition, she wants to have accurate information about the future planning that is imposed by government. She perceived that having certificate on her hand is not enough, since government reserves the right to expropriate her land in case of the government needs it for physical construction.

The misbehaviour of BPN is not a tale. According to Combating Corruption Commission (*Komisi Pemberantasan Korupsi*), BPN is one of the ten government organizations with a low level integrity on public service (Komisi Pemberantasan Korupsi, 2008). The same article mentioned that those ten government organizations will be subject of strict surveillance.

Requirement Analysis

The standard of operation procedure in land service (standard prosedur operasi pelayanan pertanahan in short SPOPP) has been created in order to improve land administration service. It defines service types, legal base, document requisite, operation procedure, completing time, and fee (not fee that is charged by other organization such as Directorate of Land and Building Taxation or local government). Evaluation whether the land service has satisfied the standard or not however is difficult to be judged in manual system. The land services can be modelled better using Workflow Management System (WfMS). WfMS has capability to interpret process definitions, interacts with workflow participants, keep track of work progress, and invoke external tool if required. WfMS can be linked to LADM database to perform automatic data maintenance. Conversely, LADM provides data that is used by WfMS to assign a specific task to a participant, to execute further processes, validate a task. Integration of WfMS and LADM eventually expected to improve efficiency, business process control, data management as well as process management. Furthermore, evaluation of whole process in land administration service can be done accurately.

5.9. Support daily works

Requirement Description
Some local offices in Indonesia are still using computers merely to type certificates. The ability of computer software to offer correction on mistype, preview of work and saving their work to be continued later are the most advantageous of using computer as perceived in comparing typing machines. Some offices have introduced semi automatic processes by utilizing a mail merge facility. The database is limited to a desktop database, not a client server database. The same fact was also found on cadastre. Some local offices use computers to draw field measurements. They are mostly using CAD software with the file saved individually. Those who feel comfortable with the current system hope that ability to support daily work is available in the LADM or even managed better.

Requirement Analysis
Certificate of land right can be included in LegalDocument class. Specific situation of Indonesia cadastre can be included as attributes. The LADM provides generic attributes only because it is an international standard that is expected to be valid in whole countries in the world.

Updating cadastral map can also be made easier by providing user-friendly software. There are a lot of open source software systems that can be used as basic application such as QGIS, OpenJump, uDig and OSCAR. QGIS, OpenJump and uDig only provide a basic tool to render, editing, and printing while OSCAR moves one step further by integrate Workflow Management System (WfMS). OSCAR is based on LADM packages. A user friendly application is a matter of software development and learning process for the operators. Training should be continual process since new employee will always be recruited to replace a retiring employee. Distance learning can be applied to provide training in a more cost-effective manner.

5.10. Affordable in development and maintenance process

Requirement Description
To implement a computerized system in whole country obviously need huge fund both for hardware and software. This condition is even more important because of BPN merely relies on national budget to operate land administration service. Some local offices found it difficult to develop and maintain land information system. However, computerized processes are expected to overcome limitation of personnel in some local offices.

Requirement Analysis
With standardize data model, development of core software can be done by central BPN. It will reduce development cost dramatically. Some local offices located in area with good internet access can even use common server, located in regional office or central office. This way offers effectiveness on maintenance of hardware and software, and also office space. Human resource for development and maintenance can be centralized, it overcome the scarcity of skilful employee in BPN. It also solves

problems with double task in local offices. Local office employee responsible for data only while regional and central office responsible for software and hardware.

Current initiative to reduce the cost of software development is by adopt Free and Open Source Software (FOSS). The implementation of FOSS limited to the server operating system, and the server side application. The attempt to adopt FOSS found on KIOSK application. The application was developed with PHP, hosted on a CentOS-powered server. A user of KIOSK machine can find information about land registration service including document prerequisites, duration, fee, tracing of land title application, and notary.

Adoption of open source software may also save national budget for system development. It does not mean that open source software offers free of charge, but it fact that open source software offer lower price than proprietary software.

5.11. Reliable and easy to use

Requirement Description
BPN currently suffers from the lack of human resource availability. Government of Indonesia is running zero growth policy on recruitment of new employees. It means that the number of new employees should be the same as the number of retiring employee. As a result, a person often has a double responsibility as software/hardware maintainer and data maintainer. In case of trouble in software/hardware, he has to leave data maintenance activities and cope with the software/hardware trouble. Thus the employee hopes that the system is reliable enough to avoid accumulation task on data maintenance.

It is also a fact that computer skills of employees range from poor, to good. Central BPN regularly educates local office employees every year. It often happens that after an employee has trained, he is transferred to other district that does not run computer system or promoted to a higher position. Since there are always new users with various skills, some of them expect to have a user friendly system so they can learn it easier.

Requirement Analysis
Reliability and easiness of use of software is combination between the right choice of software and learning process. In order to support daily works and information system, LADM should be converted into spatial database. Of course people do not want to insert, update, and delete a record through SQL statement. For spatial data, LADM need GIS software that can visualize and edit spatial database. For textual data, web base client for data maintenance can be developed.

The business processes is also influence simplicity of software. A complicated business processes may result complex software development and eventually harm the users. It is true that the software should follow the business rule, but introduction of computerized system should be followed by reengineering business process to achieve effectiveness.

5.12. Accommodating two coordinate systems

Requirement Description

Indonesia makes use of TM-3 coordinate system for cadastral mapping. However, only limited number of local offices can bring their measurements into national coordinate system. The main problem is because the geodetic network does not cover whole country currently (Pusat Data dan Informasi Badan Pertanahan Nasional Republik Indonesia, 2007). Some local offices also have difficulties to get satellite imagery or aerial photograph since the national budget does not enough to cover it. As result, they conduct measurement in local coordinate system.

Requirement Analysis

SurveyPoint class provides the possibility to accommodate two coordinate systems. It stores the information about transformation used, from origin location to transformed coordinates. Location origin is coordinate based on field observation.

5.13. Can manage existing manual field document

Requirement Description

Most of local offices in Indonesia still rely on semi automatic mapping process. Some of them using digital equipment to conduct measurements but still they keep measurement sketch. The sketch is still the main source in case of boundary reconstruction needed later. However, manual system for keeping measurement sketch is vulnerable again natural disaster. Some offices also face the problem of searching old sketches because they store the sketches without good indexing. The storage room to keep the sketches is also another problem since some offices have a small office and even rent a house for office.

Requirement Analysis

Manual field document presents measurement data like distances, azimuth, and angles. Sometimes it includes some relevant information like neighbour names, natural mark, etc. Usually it is used as primary source when dispute occurs. However it should be noted here that in Indonesia, digital document is not acknowledged as legal evidence. So, the existence of scanned field document is just as back up data in case of natural disaster.

SurveyDocument class heir electrSignature attribute from SourceDocument class. This attribute can be used to keep scanned manual field document. The scanned field document must be a single file for each field document. It is better to compress scanned field document to save the file size because this data is rarely used.

5.14. Support data sharing

Requirement Description

Spatial data sharing in Indonesia is facilitated by government regulation number 85/2007. According to the regulation, the cadastral is a node of the national spatial data network. BPN is responsible for

providing a cadastral map, the geodetic network, land-use information, land value zone, regional asset zone, and others land related information within national data network initiative.

In addition to the development of spatial data network in Indonesia, currently BPN establish a data sharing with the Land and Building Tax as well as the Statistics Department. Sharing data between BPN and Statistics Department is expected to save fifty billion rupiah (Badan Pertanahan Nasional, 2008b).

Requirement Analysis
Current information technology allows organization to share geo-information without loosing any data. Other organization can retrieve, visualize or even perform spatial analysis without touching the data. The information to be shared is also can be restricted to protect privacy of somebody's properties.

5.15. Support spatial planning

Requirement Description
Spatial planning in Indonesia is often hampered by the non-availability of cadastral data. Local offices are often requested data by Regional Development Planning Board (Badan Perencanaan Pembangunan Daerah), and civil work department for road reconstruction, water way reconstruction and land consolidation.

The amount of compensation usually is the main problem during land exemption. Government usually rely on land value, while citizen prefer actual land prize. East Flood Canal plan in Jakarta area was postponed since 1993 because of disagreement between land owner and government about compensation amount. The high gap between land value and actual land prize is the most objections of citizens.

The same case also happens in Sidoarjo district. Disastrous mud volcano in Sidoarjo district has sunk six villages. The mud volcano was triggered by gas drilling, currently causing nine villages to be inhabitable. A scientific research predicts that 100.000 m3 of mud is erupted everyday. Moreover, it was predicted that the volcano will stop in 31 years, mean that the coverage of mud will be larger and larger. Currently, around 11.000 people were displaced from their village, and Government of Indonesia announces it as natural disaster. The consequence is government should provide compensation for the people who affected by the mud volcano. Since it erupted in 2006, the land compensation is not yet finish. People still disagree with government price and they become homeless until now.

Requirement Analysis
Spatial planning will be successful if the cadastral map coverage is complete. The challenge now is to complete the cadastral map. From LADM perspective, it has sale price attribute in LegalDocument class. LADM also keep land value information RegisterParcel class. The sale price information can be a good control for land value information. In case of there is a high gap between them, adjustment on

land value may take place. It keeps the land value information up to date and reflects the actual condition.

5.16. Integrated with raster data

Requirement Description
Since the geodetic network does not cover whole area, some local offices make use of satellite imagery for cadastral mapping. The non-availability of geodetic control is not the only one reason to use satellite imagery. Parcel mapping in Aceh after tsunami is another case of the usage of satellite imagery in Indonesia. Therefore, the raster data must be able to be integrated into LADM.

Requirement Analysis
SurveyDocument class can be used to integrate satellite imagery data or aerial photograph. Both satellite imagery and aerial photograph is periodically updated, therefore they need versioned object. The time series satellite is an important source to detect land use change. Rapid population growth and economic pressure has affected land use in general. Conversion rice field into housing and rain forest into palm oil plantation extremely threaten food security and environmental quality. From this view, LADM also contributes to provide possibility to monitor land use change.

5.17. Avoid cadastral data duplication

Requirement Description
Government of Indonesia separates Legal Cadastre and Fiscal Cadastre into two different departments. Legal cadastre was mandated to Ministry Department and Legal Cadastre is conducted by Badan Pertanahan Nasional. Considering the budget, indeed there is a duplication of budgets in conducting field survey and measurements.

Currently, BPN practices limited data sharing with Directorate Land and Building Taxation (Direktorat Pajak Bumi dan Bangunan in short PBB). However, this data sharing does not solve the duplication of cadastral data problems because data sharing implemented by exchange physical map (paper based) or digital file. The legal cadastre data remain maintained by BPN, and fiscal cadastre data maintained by PBB. Updating data is hard to do, and sometimes even not consistent.

Requirement Analysis
The completion of cadastral map coverage with a good database structure will avoid cadastral data duplication. LADM support both legal and fiscal cadastre. RegisteredObject class has value field that is used to store value of property. The value of property is used to calculate tax amount of a particular properties. By taking advantage from rapid development on information technology, the data can be shared through internet protocol to other department. It clear that by apply LADM, the separation between legal and fiscal cadastre in Indonesia is merely separation of department while the cadastral data is remain single.

By completing cadastral map coverage, fairness in taxation can be ensured. Furthermore, the land tax generated from citizens can be used to increase land administration service capacity including accuracy of cadastral map.

5.18. Support of land reform

Requirement Description

Currently BPN is running a land reform project. Land reform is mandated to BPN by Decision of People Consultative Assembly IX/MPR/2001. The main intention of this decision is to ensure land access for the poor. In the past, Government of Indonesia runs transmigration policy to provide better land access and distribute people from high density island into less density island. However, the project was ended in disaster. Now, land reform is activated again. Mainly state land is object of land reform.

Requirement Analysis

The role of LADM to support land reform is by providing better data management. Land reform is aimed to provide just in land access. Without good data management, it is very hard to select land as land reform object. Selection of peoples who eligible to be given land is also difficult. It can happen that peoples who have had land are given land again. By LADM, it expected that querying such information become faster, accurate and easier.

5.19. Up to date

Requirement Description

Once the parcel is registered, it may be transferred or mutated. In order to avoid fraudulence, land transfer deed should be registered. Transfer and mutation basically is a process of updating land data. In some local offices it often happens that the land certificate is updated but the land database is not. It is happen because of some local offices merely use computers to type certificate, not to maintain database. The usage of a desktop database with mail-merge facility also contributes to that situation. Since a desktop database can only be used by a single user, others user who have to type a certificate just edit the document and the database is left without updating. Failing to update database causes the data to become obsolete and does not reflect the real condition.

Requirement Analysis

Updating data after adjudication could be one of the greatest challenges for Indonesia land administration. The informal system must be avoided to provide security tenure. BPN must offer incentive to attract citizens registering their land transaction. Reducing informal cost and provides transparent process can be an incentive.

Reducing contact between BPN employee and enquirer can be reduced informal fee. The only way to reduce contact is through e-government. Applying computerized workflow management result to the transparent process. Peoples can trace their application without asking official staff. The workflow management software can be linkage to the spatial database to perform updating data.

6. Validation and application of the LADM

6.1. Introduction

This chapter discusses about validation and application of LADM. Validation is conducted by comparing the prototype with the existing model from BPN in Indonesia. Data from the existing model are transformed into LADM database – Demonstration of prototype's capability to support land administration system is also presented. The possibility to apply some LADM concepts is discussed to give description about how LADM can be grounded in real life situation, especially in Indonesia.

6.2. Validation of the LADM

Model validation is concerned with determining whether the simulation model represent the real land administration system accurately or not. A valid model is both accurate and able to meet the objective of simulation project for which it being used (Robinson, 1994). Robinson (1994) provides some validation methods including face validity, comparison with the real system, and comparison with others models. Face validity through demonstrating the model and comparison with other model will be used to validate LADM for Indonesia case.

6.2.1. Demonstration

In order to demonstrate LADM, a database prototype was created. Demonstration was then made to address the potential use of LADM in current practice. Demonstration was completely made in open source software environment. PostGIS is used as database management system. Quantum GIS, UMN Map Server, Apache, and OpenLayer are used as thick client, map server, and thick client development tool subsequently.

6.2.1.1. The prototype

The prototype is created for all packages including the person package. It is because currently a person database does not exist in Indonesia. This situation has forced BPN to input person information into its database. However, accuracy of the person data is not guaranteed. In the future, each package should be maintained by a proper organization. For example, the person package should be maintained by ministry of home affairs for natural person and ministry of law for non-natural person. In the current legal framework, BPN has the responsibility to develop and maintain remaining packages (immovable, surveying, geometry and topology as well as legal/administrative package). PostgreSQL with spatial extension (PostGIS) is used as database management system.

Topology package is implemented using PostGIS topology. All (spatial) topology functions are stored in a certain schema named topology. Geometries are constructed from face, edge_data, and node. All those tables located under kadaster schema (depending on topology name definition, in this case kadaster). Spatial description value in RegisterParcel table is stored as TopoGeometry. TopoGeometry

actually is Postgres domain type. This domain type is defined as array of topology name, feature type, layer identifier, and topology element array. The topology element array is a bi-dimensional array of integer. It keeps face identifier and element type (point, line, or polygon). It means that spatial description can be constructed by one or more faces.

The prototype represents two sub-districts which are Menteng and Tanah Abang. It is located in Central Jakarta municipality. Central Jakarta municipality was selected because it is covered by data entry project within Land Office Computerization framework. Data content is not changed from original, so the prototype reflects real data. Following are statistical information of the prototype:

Table Name	Records Number
groupperson	1682
person	17093
member	6868
right	17094
mortgage	2557
registerparcel	22087
face	22091
edge	59258
node	39194

Table 5. Statistic of the prototype

6.2.1.2. Viewing cadastral map

Almost all open source GIS softwares like Quantum GIS, uDig (User-friendly Desktop Internet GIS), or OpenJump have capability to render spatial data that is stored in PostGIS database. Among those three, Quantum GIS is the best candidate for thick client application to satisfy internal user requirement (see section 5.11).

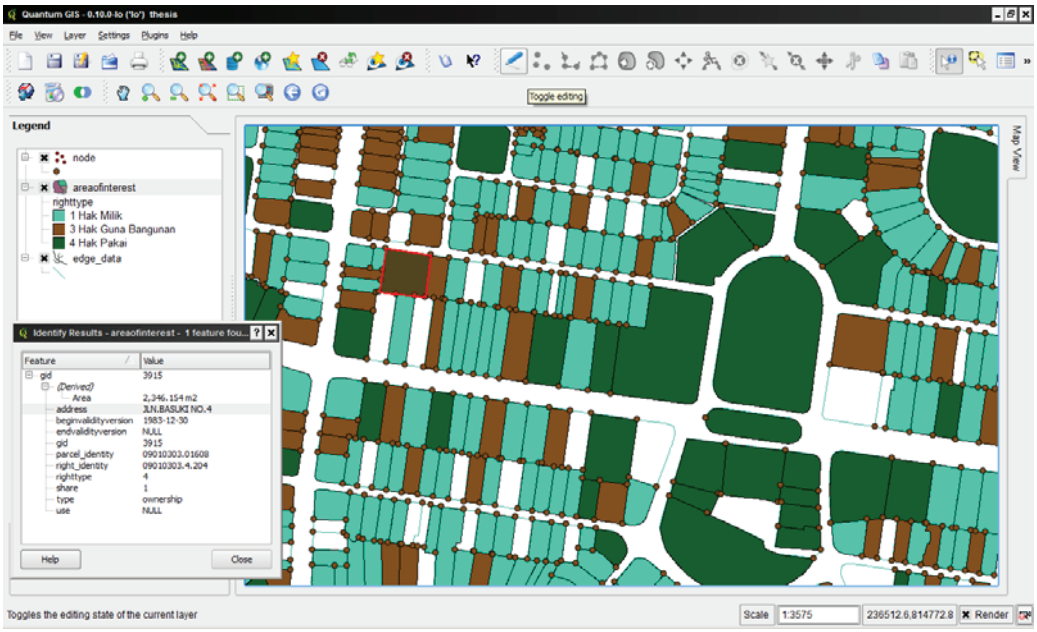

Figure 8. Thick client with Quantum GIS

It has a simple user interface, stable, and fast enough. QGIS provides basic tool for viewing and editing cadastral map, while an advanced tool for reconstructing field measurement can be developed as plug-in. Figure 8 shows Quantum GIS render cadastral map directly from the prototype.

To satisfy external user requirements (see section 5.5), enabling land information system on internet can be made by developing portrayal service. In open source area, OGC map service is a widely accepted specification and supported by most web map server. Here is an example how to invoke OGC map service:

http://localhost:8080/cgi-bin/mapserv.exe?map=c:/ms4w/apps/thesis/thesis_wms_config.map&SERVICE=WMS&VERSION=1.1.1&REQUEST=GetMap&LAYERS=Parcel&STYLES=&SRS=EPSG:23834&BBOX=236402,814207,237329,814768&WIDTH=900&HEIGHT=600&FORMAT=image/png

As result the web map service will return a bitmap represent parcel layer for given bounding box. For layman, invoking that long URL can be serious problem. Development of thin client is needed to provide better functionality to external user. OpenLayer is a javascript library for creating interactive maps that can be used to develop thin client running in the internet browser. Below is an example of cadastral boundaries on top of google satellite image layer.

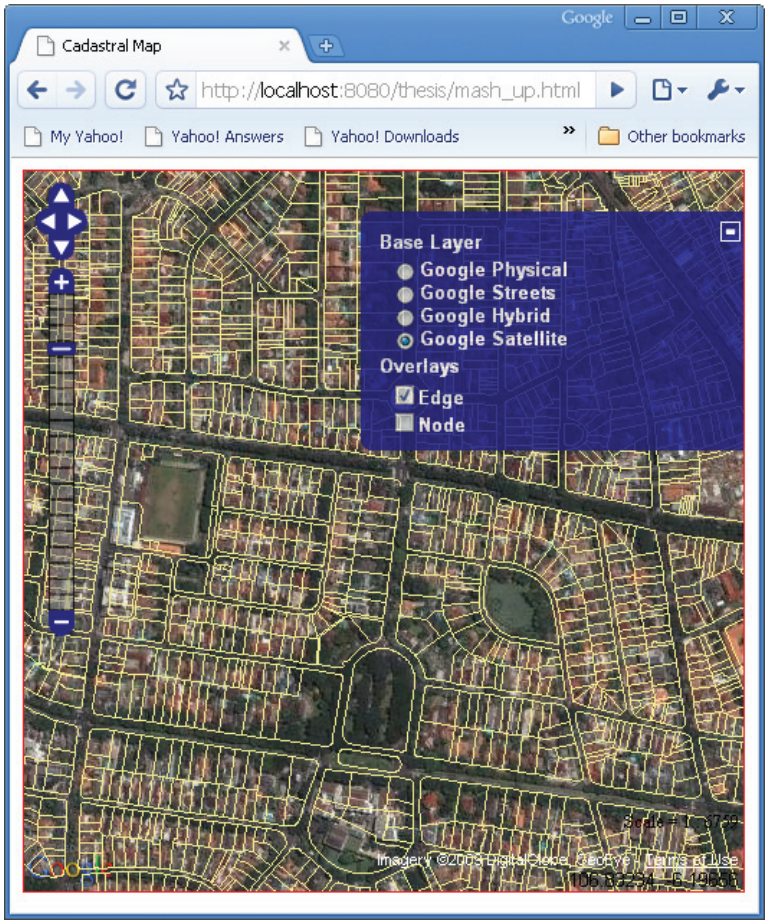

Figure 9. Thin client with OpenLayers

Enabling cadastral map on internet may stimulate involvement of citizens to validate cadastral map. Citizen can easily identify their property on top of satellite imagery. A reporting tool can be developed to report incorrect data that is founded by citizens. Involvement of citizens eventually is expected to increase accuracy of cadastral data.

6.2.1.3. Spatial data sharing

Spatial data sharing involves several spatial data providers. Each spatial data provider may use different database, meaning that access data is a variable. In order to integrate those variations, interoperability concept is emerged. Interoperability is achieved trough standardized interface, and format data. OGC web service offers several web map service specification such as web map service (WMS), web feature service (WFS), web processing service (WPS), and catalogue service for web (CSW). This section will describe the use of WFS to access spatial data that is provided by another organization.

Following statement is a sample request to WFS server:

http://localhost:8080/cgi-bin/mapserv.exe?map=C:/ms4w/apps/thesis/thesis_wfs_config.map&SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPENAME=Road&MAXFEATURES=25&OUTPUTFORMAT=GML2

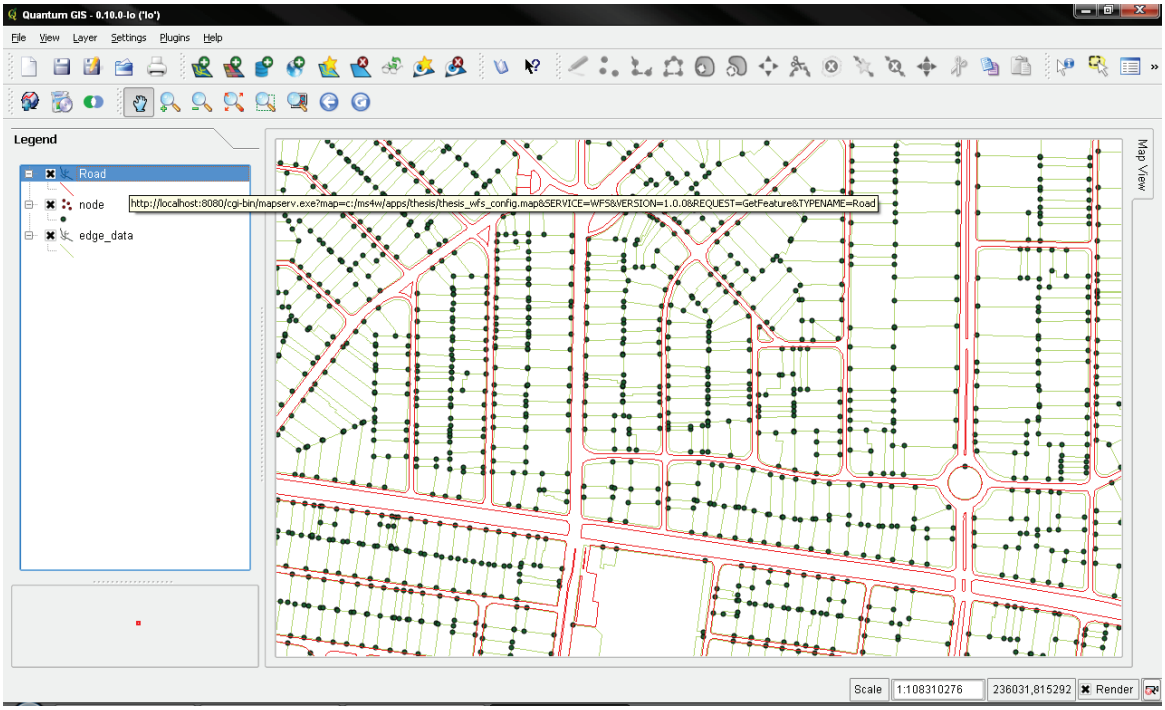

Figure 10. WFS layer in Quantum GIS

Given request above, WFS server will return GML to client. In order to render the server response, client software must be able to convert GML into graphic. QGIS is one example of client application that is able to convert GML into graphic as shown in figure 10.

Suppose that road data is maintained by civil work department and they share the data through WFS server. Through QGIS, cartographer in BPN can include road layer (red line in the figure above) in QGIS (the balloon provides information about where the layer come from). In real life, BPN may need some spatial dataset from external organization such as municipality, forestry department and national mapping agency.

6.2.2. Comparison with existing data model

The existing BPN data model is obtained from data entry project in Central Jakarta. It was developed in 2006 and has become the most comprehensive data model among any other data model in BPN. Even though the existing model is not explicitly organized into packages, one still is able to recognize to what package the exiting class belongs.

6.2.2.1. Person package comparison

The person package in existing data model is constituted by one single table. Relationship between right and person is many-to-many, so it allows joint ownership. However, share information is not covered by existing model. It is not because share information does not exist in Indonesia but it really is a data model defect. In order to add share information, local office add share amount at the end of owner name. From existing database query, it is not very difficult to get such data. Here is an SQL statement to extract person data with share information:

```
select name from person where name like '%/%BAG%';
```

The keyword '%/%BAG%' is an arbitrary keyword. It may not give complete results of share information that we are looking for. However, it gives enough description about existing data model defect. The SQL statement above returns 222 rows out of 17965 rows from the prototype. Here is an example of share information taken from co-ownership of a family (inside the box in figure 11):

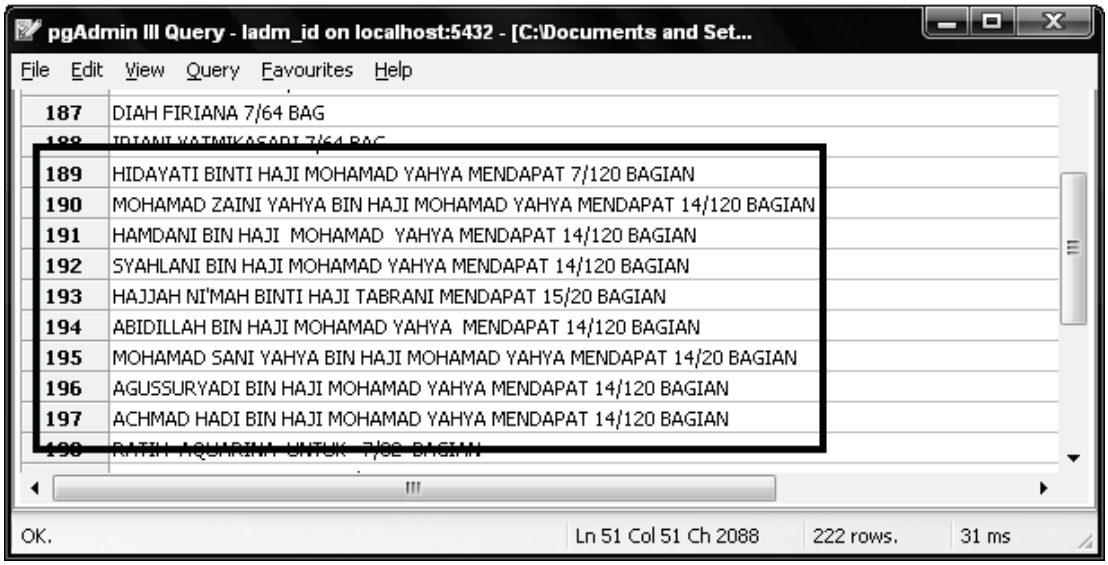

Figure 11. Share information in existing model

From the figure above, the word “MENDAPAT xx/xxx BAGIAN” means “HOLD xx/xxx of SHARE”. One may say that name in person record does not represent correct name of land owner, because they are given additional information. Improvisation of existing data model indeed is needed to provide precise information. In LADM, each owner can be stored in person table, and than each person is related to a group person record. Share amount can be stored in member table, which is cross table of person table and group person table. Suppose that share information is stored on member table, the SQL statement to extract share information is therefore:

```
select gp.gid, gp.name, p.gid, p.name, m.share
  from member m, person p, groupperson gp
 where m.grouppersongid = 1277
   and m.grouppersongid = gp.gid
   and m.persongid = p.gid;
```

The result of SQL statement above presented in figure 12. The prototype shows that share constraint is valid for Indonesia, which is equal to one. Furthermore, group name and person name can be updated to present the exact name of the owner.

	gid integer	name character varying(100)	gid integer	name character varying(100)	share numeric(5,3)
1	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	959	MOHAMAD ZAINI YAHYA BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117
2	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	13984	HIDAYATI BINTI HAJI MOHAMAD YAHYA MENDAPAT 7/120 BAGIAN	0.058
3	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	25611	ACHMAD HADI BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117
4	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	5250	AGUSSURYADI BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117
5	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	14343	MOHAMAD SANI YAHYA BIN HAJI MOHAMAD YAHYA MENDAPAT 14/20 BAGIAN	0.117
6	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	14713	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117
7	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	24091	HAJJAH NI'MAH BINTI HAJI TABRANI MENDAPAT 15/20 BAGIAN	0.125
8	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	19553	SYAHLANI BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117
9	1277	ABIDILLAH BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN, dkk	7358	HAMDANI BIN HAJI MOHAMAD YAHYA MENDAPAT 14/120 BAGIAN	0.117

Figure 12. Share information in LADM

6.2.2.2. Legal/administrative comparison

The existing data model keeps chain of ownership. Here is the UML model of existing database to present chain of ownership:

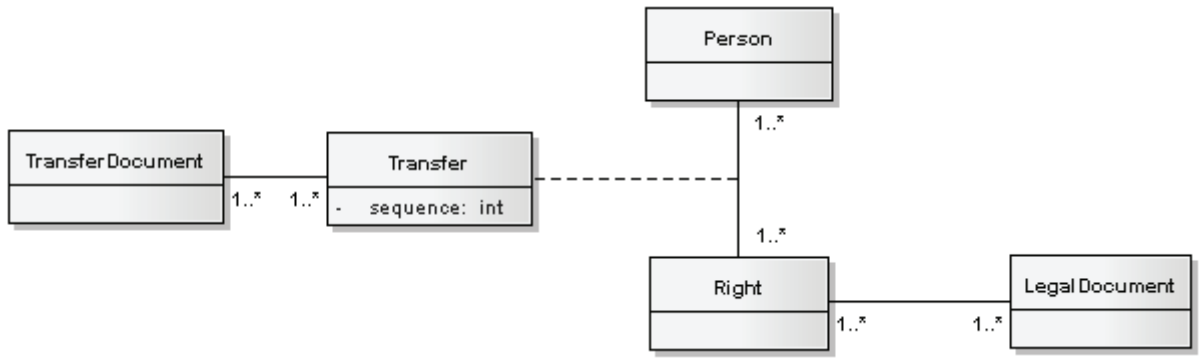

Figure 13. Existing legal/administrative package

Every right transfer is supported by transfer document. Transfer document takes form of trading deed, court decision, bidding summary, and inheritance deed. Every transfer usually is recorded until certain periods. From UML model above, present owner is indicated by the highest transfer sequence.

Chain of ownership is completely written in the certificate of land even though by Indonesian law BPN should be able to keep chain of ownership for minimum five years. Some importance of ownership in Indonesia can be described as follow:

1. Previous owner is needed for corruption investigation. Treasures of a suspect, including land right, within certain period in the past and its motive transfer is used to judges whether those treasures are corruption product or not.
2. Previous owner data is also used to control treasures of government official within their leadership period.
3. Tracing back chain of ownership in case of dispute or criminal investigation (corruption or money laundry).

In LADM, chain of ownership is managed by versioned object. The endvalidityversion and beginvalidityversion keep information about ownership period. When a person or groupperson achieve a right, the beginvalidityversion value will be available and the endvalidityversion value will be null. Further more, when a person or group person release their right the endvalidityversion value will be available. Therefore, the present owner can be determined by selecting null value for endvalidityversion column. Chain of ownership can be obtained by selecting non-null values for endvalidityversion column and order it in ascending. Exceptions occur on land right with certain period of validity such as HGB, HGU, and HP (see section 4.2.2.4). The endvalidityversion of these types of right is determined when these land right was issued. The present owner is determined by searching endvalidityversion which has value greater than today.

The protoype includes this concept. In order to get present owner and legal document number for a given registerparcel in LADM, following SQL statement can be used:

```
select r.type, r.beginvalidityversion, r.endvalidityversion, p.name,
rp.identity, l.number
  from public.right r, public.person p, public.registerparcel rp,
public.legaldocument l
 where r.persongid = p.gid
   and r.legaldocumentgid = l.gid
   and r.registerparcelgid = rp.gid
   and rp.identity = '09010303.06193'
   and (r.endvalidityversion is NULL OR r.endvalidityversion >=
CURRENT_DATE);
```

The predicate NULL for endvalidity version is needed in case of full ownership when there is no endvalidityversion at present. For long lease, endvalidityversion can be in the future. Therefore, the combination of endvalidityversion is null or endvalidityversion greater than current date is used. Figure 14 shows the result of present owner query. As it shown, the present owner hold land right since 28/08/2008 untill now.

	type character(20)	beginvalidityversion date	endvalidityversion date	name character varying(100)	identity character(14)	number character varying(100)
1	Hak Milik	2000-08-28		THE SIOE HONG	09010303.06193	09010303.1.523

Figure 14. Result of present owner query

From the same given registerparcel above, query of all previous owners can be done by following SQL statement:

```
select * from
(select r.transactiontype, r.type, r.beginvalidityversion,
r.endvalidityversion, 'Person':: character(11) as remark, p.name,
rp.identity, l.number
  from public.right r, public.person p, public.registerparcel rp,
public.legaldocument l
 where r.persongid = p.gid
   and r.legaldocumentgid = l.gid
   and r.registerparcelgid = rp.gid
   and rp.identity = '09010303.06193'
   and (r.endvalidityversion is not NULL OR r.endvalidityversion <
CURRENT_DATE)
union
select r.transactiontype, r.type, r.beginvalidityversion,
r.endvalidityversion, 'GroupPerson':: character(11) as remark,
gp.name, rp.identity, l.number
  from public.right r, public.groupperson gp, public.registerparcel
rp, public.legaldocument l
 where r.grouppersongid = gp.gid
   and r.legaldocumentgid = l.gid
   and r.registerparcelgid = rp.gid
   and rp.identity = '09010303.06193'
   and (r.endvalidityversion is not NULL OR r.endvalidityversion <
CURRENT_DATE)) as history order by beginvalidityversion;
```

The figure below show the result of query above:

	transactiontype character(20)	type character(20)	beginvalidityversion date	endvalidityversion date	remark character(11)	name character varying(100)	identity character(14)	number character varying(100)
1	Pendaftaran Pertam	Hak Milik	1966-09-21	1977-04-13	Person	CLARA SALAMONG	09010303.06193	09010303.1.523
2	Ganti Nama	Hak Milik	1977-04-13	1977-11-03	Person	LISBETH CLARA SALMON MATHIAS	09010303.06193	09010303.1.523
3	Pewarisan	Hak Milik	1977-11-03	1977-11-04	GroupPerson	KELUARGA MATHIAS	09010303.06193	09010303.1.523
4	Jual Beli	Hak Milik	1977-11-04	1981-02-24	Person	HERY HENRY	09010303.06193	09010303.1.523
5	Jual Beli	Hak Milik	1981-02-24	2000-08-28	Person	TAURUK BIN RAHMAD HARLARAH	09010303.06193	09010303.1.523

Figure 15. Result of transfer history query

Briefly, the first owner got land right from adjudication process on 21/09/1966. She corrected her name on 13/04/1977, perhaps because it was mistyped. It means that the first and second owner remains the same person. Third transfer is inheritance, taken place on 03/11/1977. The land was transferred to group person which is the owner inheritors. Furthermore, the member of group person can be obtained using SQL statement as described in section 6.2.2.1. A quick transfer is taken place after inheritance. On 04/11/1977, the land was sold. On 24/02/1981, the land was sold again and finally the present owner bought this land on 28/08/2008.

An adaptation is needed for multiplicity of Right-LegalDocument class association. In Indonesia, one land right may have many legal documents. For example, one right is asserted by one or more title document (in case of a person/groupperson loosing their title document), deed, and court decission. One legal document, for example title document, may describe more than one right. The same

adaptation is also needed for Right-Mortgage association. In Indonesia, one mortgage may have one or more land rights as collateral. Conversely, one land right can be collateral of one or more mortgages.

6.2.2.3. Geometry/topology package comparison

Conversion from cadastral maps from paper based map into digital format usually makes use of CAD software. Within data entry project framework, digitalization of cadastral map in Central Jakarta municipality also makes use of CAD software. Cadastral boundaries and its unique identifier are validated against topological rules, so called session topology. By session topology it means that every time cadastral maps file is opened or altered, the topology information is recomputed.

In LADM, the topology package is imported from ISO 19107 (Spatial Schema). Topology primitives which are face, edge, and node are used to represent geometries. Topological relationship among topology primitive is stored in the database explicitly during insertion or modification of them, so called persistent topology. Simple geometries such as polygon, multi-polygon, linestring, multi-linestring, point, and multi-point can be constructed based on valid topology primitive.

From the prototype, one can confirm that session topology that is obtained from Central Jakarta cadastral maps can be converted into PostGIS persistent topology. Steps to convert session topology into persistent topology are included in annex. Two main issue of PostGIS topology are currently (1) no GIS software support topogeometry column for visualization and (2) its performance to covert topogeometry column into simple geometry. In order to be able to visualize topogeometry column, one need to create a view to convert topogeometry column into simple geometry. Unfortunately, it takes roughly half an hour to produce 22,087 polygons using following machine specification:

- Processor: Intel® Core™ 2
- Memory : 1.5 GB

However, slow performance of PostGIS topology is understandable because it is a very experimental tool provided by PostGIS developer, intended as proof of concept only[1]. So far, all topology functions are written in PL/PGSL this means that best performance can not be achieved. There are some workarounds to cope with this problem in real life situation as follows:

1. Create a batch file that is automatically run after office hours to dump geometry from topogeometry column.
2. Create record trigger to convert topogeometry column into simple geometry that is fired after insertion or modification of a record.

Simple geometries that are produced from both scenarios above can be stored as additional geometry field in registerparcel table. This simple geometry should not be maintained by hand, it is merely for visualization purpose.

Topology datamodel in Postgis provides limited spatial function only. However, one may get rich spatial function by converting topogeometry object into simple geometry object. For example, area calculation can be done by executing folowing SQL statement:

[1] E-mail communication with postgis topology developer. See http://postgis.refractions.net/pipermail/postgis-devel/2008-September/003597.html

```
select ST_AREA(topology.geometry(feature)) from registerparcel where
gid = 8155;
```

From SQL statement above, feature is a column name that stored topogeometry object in registerparcel table. The topology.geometry function convert topogeometry object into simple geometry.

6.2.2.4. Immovable package

The existing model provides dispute information by associating parcel class to dispute class as depicted in UML class diagram below:

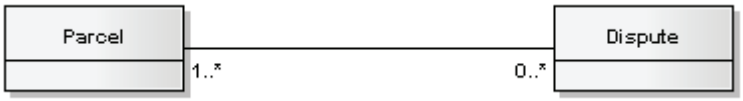

Figure 16. Dispute class

In LADM, dispute or conflict information can be stored in the Right class (subclass of RRR class). A small adaptation is needed by introducing conflict and dispute records in the righttype code list. The advantage of this approach is conflict or dispute information can be associated to the Person/GroupPerson and the LegalDocument classes.

Furthermore, LADM provides a field that is named parcelname in registerparcel class. Such field is not available in existing model. In Indonesia, it is common that public area such as park has a name. The prototype provides an example of this condition. Following SQL statement will extract information of a parcel:

```
select use,computedsize,parcelname,identity,address from
registerparcel where gid = 8155;
```

The result of SQL statement above is shown in the following figure:

	use character varying(50)	computedsize numeric(15,3)	parcelname character varying(50)	identity character(14)	address character varying(100)
1	Taman Kota	16175.492	Taman Suropati	09010303.06297	JLN.IMAM BONJOL (TAMAN SUROPATI)

Figure 17. Parcel Name

Because of parcel name is not accommodate by the existing data model, such information is often included in the parcel address (in the bracket from figure 17 above). With LADM, parcel name can be better managed.

6.3. Application of LADM

Oxford dictionary defines application as the practical use of something especially a theory, discovery, etc. LADM provide a set of structured concepts on land administration domain. Such concepts may exist in a particular country, but not yet adopted in formal land administration system. For example, legal framework in Indonesia acknowledges share for married woman but the share information is not imposed in land administration system. Temporal aspect, which is very important in the deed

registration system, is also not well managed so far. The possibility to apply some LADM concepts is presented below.

6.3.1. Women's access to land

According to national census 2000, the number of women in Indonesia reached 210 million or 49.7% of total population. However, statistical data show that women's quality of life on education, health, law protection, economic and politic is less than men. Women exploitation and violation is reported to increase (Wahyurini, 2007). Government of Indonesia currently encourages women to take strategic position in all human life aspect including politic, education and welfare. The political will of government to strengthen women position is clearly stipulated by law 2/2008 about political party. The law provides 30% of house representation position to women for the next coming election.

In Indonesia, women are allowed to own land as well as men. However, there is no good statistic data that describes the composition of women-owned land compared to men-owned land. Looking from statistical data, women main job status is less than men (Kementrian Pemberdayaan Perempuan, 2007) so it can be expected that women-owned land is less than men-owned land. Land administration system can help to empowering women through co-ownership. Co-ownership can ensure to women land access. It is a fact that women-headed household increases because of labour migration, divorce, and the death of husband (Kompas, 2008).

LADM provide share attribute in Right and Member class. This attribute can be used to register share data between husband and wife. Both statutory law and Islamic law support property share, even though the amount of share is different (see section 4.2.2.6). Currently registration of co-ownership of land is not obliged in land registration. Adopting co-ownership concept can help government initiative to empowering women through land administration system.

The main challenge to adopt co-ownership concept is social structure in the society. Women in Indonesia accept the situation being man's subordinate. Promotion of gender equality must be done intensively together with other departments. In LADM co-ownership can be implemented.

6.3.2. Temporal aspect

Indonesia operates land administration system with deed registration. From land data entry project in Jakarta province, the temporal aspect is indicated by flag with value zero or one. Zero means that the record is frozen while one mean the record is active. The weakness of current system therefore is that it does not clearly inform the time span of the record. There are two types of temporal aspect in LADM which are event-based and state-based. Event-based model can be applied to customary right while state-based can be applied to statutory right. In customary right, the right on particular land often is tied to leadership period. For example in Bali case, *tanah bukti* is awarded to *prajuru desa* (see section 4.2.3.2) during their leadership period. State-based model is suitable for statutory right. Hak milik which never expires will always have null value for endValidityVersion column. The other right should have a valid date for this column. The expiration date is usually known by the time the right is registered. The data of expiration can be a good tool to predict national revenue from BPHTB.

6.3.3. Restriction

Restriction has a special place in Government Regulation number 40/1996 (see section 4.2.2.4). Article 13 stipulates that if the land with Hak Guna Usaha impounds other lands from the public road or water, then the holder of the Hak Guna Usaha is required to provide the exit road or water or other convenience to the impounded land. Land with Hak Guna Usaha has minimum area of five hectare, maximum twenty five hectare for a personal owner and can be larger than twenty five hectare for a company. Obviously that land can block other land. Recording the restriction can avoid conflict between Hak Guna Usaha with surrounding lands. Another type of restriction can be applied on electricity power-line tower. It is common in Indonesia that electricity power-line tower is erected on a private land. The land right of the tower footprint usually is given to the electricity company. Without apply restriction, the owner of the tower may get difficulties to access the tower for maintenance even though they hold a land right for their tower.

Adoption of restriction for implementation in reality and in the registration may also support in reduction of the risk of annual flood in Jakarta. There are lot of informal settlements at the edge of Ciliwung River in Jakarta as shown in figure 18.

Figure 18. Informal settlement at the edge of Ciliwung river

The informal settlements impede water flow and flooding surround area. Flood is not only harmful for the city in general but also dangerous for people who live in informal settlement surround Ciliwung River. Including restriction area in the cadastral map offers possibility to control a risky building near by the river. Together with rule enforcement, restriction information can save the city and its citizens. It is realized that resettlement of informal settlement is not an easy task. Willingness of both government and citizen to increase quality of life is key factor to adopt restriction concept.

6.3.4. Responsibility

Responsibility on formal land information system in Indonesia is limited to the particular land where the right is given. Extending the responsibility to surrounding area of a particular parcel can give an advantage to land owner and environment in general. In Indonesia, there is a tendency to locate a business-oriented building such as a mall, office, hotel, and resort near by a beautiful landmark like river, estuary, lake, and beach. In case of the landmark is included in the given land right, the owner is

willing to maintain the landmark otherwise they will simply maintain their own land. The pictures below address that situation.

Figure 19. Lake Pamulang (left) and Lake Cipondoh (right)

The lake of Cipondoh is included on the land right held by the shopping centre near by. The shopping centre hires personnel to maintain the lake. As result, the Cipondoh Lake is well maintained. The water quality is good enough, and during week end a lot of people visit the lake with their family. Contrary, the Lake of Pamulang is seriously degraded. Bushes and garbage are every where. The water is smelly. The lake of Pamulang is not included into land right owned by near by shopping centre.

Including lake to the land right may give possibility to the owner to maintain the lake. On the other hand, the owner also can convert the lake into another use. Harian Umum Sore Sinar Harapan (2006) reported that the coverage of lake has decreased by 50% in Jabodetabek (abbreviation of Jakarta-Bogor- Depok-Tangerang-Bekasi area). Most of them were converted into housing. Because of the land price in Jakarta is very high, citizens tend to seek alternative housing near by Jakarta. However, the expansion of development is not followed by strict control that ensures environment sustainability.

The better solution to ensure the sustainability of lake can be done by giving responsibility to the owner instead of including the lake into land ownership. Responsibility will disallow the land owner to convert the lake, at the same time impose them to maintain the lake. For the shopping centre case, it is really a mutual symbiosis. By maintaining the lake, the shopping centre will gain advantage from beautiful scenery of the lake. They can locate a restaurant near by the lake for example to attract visitors.

6.3.5. Serving parcel

Serving parcel can be applied for social /common facility (*fasilitas sosial/fasilitas umum*) in the housing complex. The social/common facility within housing complex is public facility with restricted access. By public it means that every resident in the housing complex can use it. By restricted means that people who are not belonging to the housing community can not use the facility. The housing community usually use social facility/common facility as gathering place, play ground and for celebration. Figure 20 shows a sketch of a housing complex in Depok to address the possibilities of adopting serving parcel for social facility/common facility.

From the picture, there are two parks and each park serves every parcel in the housing complex that is bounded by permanent fences. Park is a kind of social/common facility. All resident in the housing complex pay a monthly fee to maintain both parks and they merit from this by using the park for gathering, or children playground.

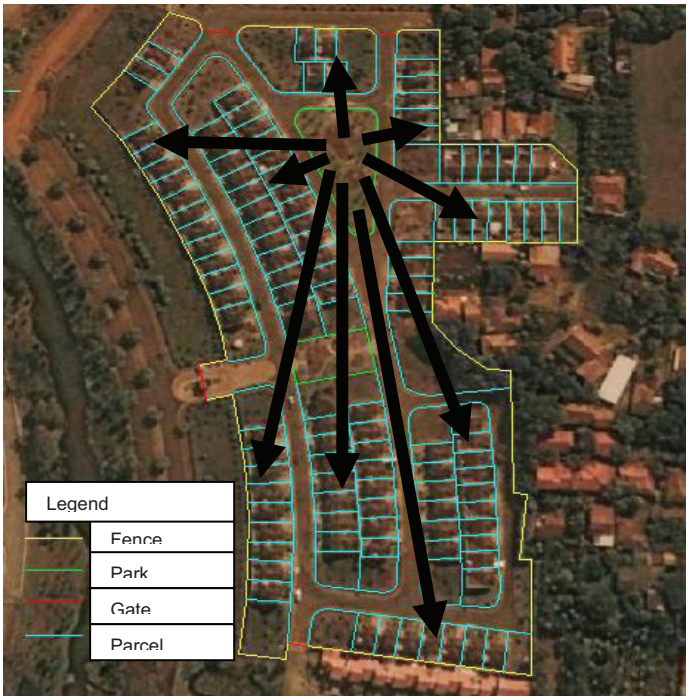

Figure 20. Serving parcel

6.4. Unapplicable classes yet

For simplicity of the system, some classes need to be omitted for Indonesia case. However, in the future those classes may need to be included. Those classes are AdminParcelSet, LegalNetwork, OtherRegisterObject, NonGeoRealEstate and Movable class.

6.4.1. AdminParcelSet

Aggregation of parcel to form AdminParcelSet will never achieved by current legal framework. It is because current legal framework omits forest area from land administration system. Instead of AdminParcelSet, administration class need to be included in the model. Administration class should has one-to-many relationship to parcel class. This allows the system to inform the location of the parcel. Location of the parcel is necessary to calculate tax revenue for a given administration unit. The tax is transferred to central government and than is distributed back to each administration unit based on their contribution to national revenue. Spatial query can be used to get parcels belong to given administration unit but this process is more expensive.

6.4.2. LegalNetwork

Utility network actually is not a registration object in Indonesia. However, in the future this can be a subject for registration. High voltage power line network is one example. Currently only the lands where electrical tower is built on are subject of registration. In the big cities, power line often passes

high density settlement. Every time a new power line is established, the people near by power line refuse the plan. They are afraid that electrical radiation emitted by power line could harm them (Antara News, 2007). From land administration perspective, first it should be clear how far the high voltage electrical radiation affect its surrounding space. Once it is clear, 3D registration to power line can be applied to make it legally protected. The land right of people living under power line therefore is arranged in such away that it does not overlap with power line legal space. Registering power line is not only aimed to protect the power line itself, but also people who live below the power line. It happens not only once that the power line tower is broken. Such a case possibly damages settlements along power line path. From land administration perspective, it will become clear who violates who's right if the power line is registered as 3D object.

6.4.3. OtherRegisterObject, NonGeoRealEstate, Movable Class

Land administration in Indonesia currently covers immovable property only. Furthermore, immoveable property restricted to land and apartment only. OtherRegisterObject or NonGeoRealEstate object maybe exists in customary tenure, for example seasonal right to crop fruit from existing tree on customary land. Since this research only reviews customary tenure in Bali, such case is not applicable. It is strongly recommended that further research on customary tenure is conducted for whole country to get a complete description of customary land tenure system within Indonesian territory.

7. Conclusions and recommendations

7.1. Research questions revisited

Research questions that are raised in section 1.4 will be discussed in this section. The discussion is based on the discussion in chapter 5 and chapter 6.

Is LADM valid for land administration system in Indonesia?
Through face validity and comparison with the existing model, most of LADM classes, associations, and constraints are valid for Indonesia. Almost all of the user requirements are accommodated by LADM. However, adaptation and extension of the LADM is needed especially for code lists in order to reflect specific requirements from localities in Indonesia.

What LADM concepts are possible to be applied in Indonesia?
Some LADM concepts are potential to be adopted as discussed in section 6.3. In short, those concepts concern women's access to land, empowering indigenous people, and environmental protection.

What classes need to be implemented and what classes not?
Some classes in LADM are compatible to already existing model classes in the data model that is already available in Indonesia. Those classes are Person, Right, RegisterParcel, SurveyDocument, LegalDocument, Mortgage, SurveyPoint, GroupPerson, and Member class. Some LADM classes are supported by legal framework but are not yet implemented in current practice. Those classes are Responsibility, Restriction, and ServingParcel. The rest are classes that for time being is difficult to be implemented due to legal framework and organizational arrangements. Unimplemented classes discussed in section 6.4 are AdminParcelSet, LegalNetwork, OtherRegisterObject, NonGeoRealEstate, and MovableClass.

What extensions of LADM (including classes, attributes and associations) need to be implemented in Indonesia?
No extensions needed for classes. Disputes can be included as a right type. The chain of ownership can be derived from the LADM data set. No new attributes have been introduced. In two cases the multiplicity between classes need to be changed. The first is multiplicity for Right-LegalDocument association. It should be many-to-many relationship. The second is multiplicity for Right-Mortgage association. It should be many-to-many relationship as well.

What are the challenges when implementing the land administration domain model in Indonesia?
Challenges to implement LADM in Indonesia mostly come from outside technical part. The LADM concept works from technical perspective – and has been implemented as a prototype. Those challenges briefly can be mentioned as rule enforcement, and human resources development to develop and maintain LADM.

7.2. Conclusions

Base on previous discussion, following conclusions can be drawn:

1. A wide range of user requirements in Indonesia is accommodated by LADM. Modification or extension of code list indeed is needed to be done to adapt LADM with the localities. Comprehensive study on localities will contribute to the enrichment of land data, empowering vulnerable groups, and in line with decentralization spirit.
2. The adoption of LADM in Indonesia is technically possible. The existing data model from Indonesia including person, legal/administrative, geometry and topology, surveying, and immovable packages can be transformed into LADM. The differences between LADM and existing model may lead to modification of data content, for example in case of introduction of versioned object, share, and parcel name. Eventually, accuracy of land data is expected to increase by adopting LADM concept. Shares, temporal aspects (chain of ownership) and disputes can be better managed with LADM. Transforming manual data into digital format also helps BPN to stimulate citizen involvement on land data validation in order to increase its accuracy.
3. Beyond the user requirements, LADM give possibilities to enhance current land administration practice in Indonesia such as environment protection, recognition of customary right, and gender access to land, development of infrastructure, and disaster management. The application of LADM is not merely a technical issue. Technical issue matters, but the other activities such as inter-organization cooperation, restoration of business model, and rules of enforcement must be taken into account in order to apply LADM in Indonesia.
4. Implementation of LADM with proper IT policy can reduce data maintenance costs and development costs. The separation of data between legal cadastre and fiscal cadastre can be avoided. Person package is not necessarily maintained by BPN. Supporting data for land administration from other organization can be obtained by using web service. The main advantages of data sharing are: avoid data duplication and keep the data up-to-date because each organization focuses to maintain data under their main business.
5. In order to simplify the model, some classes such as LegalNetwork, OtherRegisterObject, and NonGeoRealEstate are most likely to be omitted for this moment. For the time being, those classes are not part of land administration system in Indonesia. However, in the future such class might be needed.
6. UML is a good platform for development. The UML model could be used to generate the PostgresSQL database almost automatically – some manual checking and changing was needed. The MDA approach looks very promising – it woks platform independent.

7.3. Contribution of this work

In short, contribution of this work can be stated as:

1. The validation of LADM in a specific country which is Indonesia. LADM is being submitted as international standard on land administration domain. As international standard, it should be valid for many countries in the world. Concerning the importance of land administration especially to combat poverty, contribution of countries in the world to validate LADM is a crucial factor to make LADM an international standard. The more validation is done, the more acceptances can be expected.

2. The provision of a country profile for further development of LADM. The fact that LADM is still under intensive discussion in ISO TC 211 means that LADM still needs to be enhanced. Ideally, enhancement can be done if only sufficient information about land administration system of country is available. Providing country profile is a challenging task for land administration professional due to social/culture and language barriers among countries. The more country profiles are available, the more precise the LADM can be expected.
3. Addressing some possibilities to apply LADM concept in real life situation to enhance land administration for a specific country, in this case Indonesia. Validation of LADM does not only benefits LADM development but also the country where it is validated. LADM is developed based on expert discussions and experiences, and international directives (OGC, UN-Habitat and FIG). Environmental protection, empowering vulnerable groups, disaster management, and infrastructure development is supported by LADM. Environment protection can be managed better through all kind of restriction. Vulnerable group like women can be protected better by register their share in the land right. Indigenous people with their adat right can also be accommodated by LADM. Eventually, a better future of our world can be achieved through a shared ontology of land administration concepts.
4. The implementation of the LADM is possible in a distributed and decentralized environment. It is because the most variable within land administration system in Indonesia which is customary law is accommodated. Integration of distributed component can be done through service oriented architecture which is discusses in section 6.2.1.2 and 6.2.1.3.

7.4. Recommendations

This section provides some recommendations that are worth to be considered. These recommendations are the following:

1. It is recommended that BPN establishes a pilot project to implement LADM in several real life situations. Implementation of LADM is not only done within a technological approach but in comprehensive project including the possibility to record customary land, ensure women's access to land, and support environmental protection. LADM can de introduced in a de-centralized environment but a standardised data model can be used fro development of nationwide databases which can be linked to SDI.
2. Standardize land data content. The prototype shows there are a lot of erroneous data that may come from mistyping or in-proper database structure. Standardization of land data content will provide criteria for data validation. Validation of data is really a challenging process and working in digital environment give possibilities to involve citizens for data validation.
3. Establish cooperation with both government and non-government organizations to support LADM application and consider business process re-engineering so that digital environment can enhance land administration service.
4. Further research on customary land is recommended to give complete description about existing customary tenure systems so that standard model can be extend accordingly.
5. Further research in relation to maintenance processes is needed. Building a data model is a just a beginning of long process of land administration development. Once land data is recorded, it must be maintained to keep it up-to-date. It will be a great challenge to address how process modelling can take advantage from standardized model.

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Appendix 1: The UML class diagram

The UML at Glance

The Unified Modelling Language (UML) is a general purpose visual modelling language for system (Arlow and Neustadt, 2005). UML was approved by the OMG™ as a standard in 1997. Over the past few years there have been minor modifications made to the language. UML 2 is the first major revision to the language.

According to (Rumbaugh et al., 2004), UML is composed of three building block are things, relationships and diagram.

Things are the modelling elements themselves. UML things may be partitioned into:

1. Structural things – the nouns of a UML model such as class, interface, collaboration, use case, active class, component, and node.
2. Behavioural things – the verb of a UML model such as interactions and state machines.
3. Grouping things – the package which is used to group semantically related modelling elements into cohesive units
4. Annotational things – the note which may be appended to the model to capture ad hoc information.

Relationships are semantic (meaningful) connections between modelling elements. Connections can happen among objects or classes. Connection between objects is known as link and connection between classes is known as association. In UML, the connection is depicted by path. There are two styles for drawing paths:

1. Orthogonal where the path consists of series of horizontal and vertical segments
2. Oblique where the path is a series of one or more sloping lines.

The style is a matter of personal preference. Both styles may even be mixed together to makes the diagram clearer and easier to read.

Diagrams are window or views into UML model. Diagrams show collection of things that “tell a story” about the software system and are the way of visualizing what the system will do or how it will do. There are nine different diagrams as depicted in figure 4. The UML diagram is divided into those that model the static structure of the system and those that model dynamic structure of the system. The static model captures the things and the structural relationships between things. The dynamic model captures how things interact to generate the required behaviour. UML diagrams are human readable and yet are easily rendered by computer-assisted software engineering (CASE) tool.

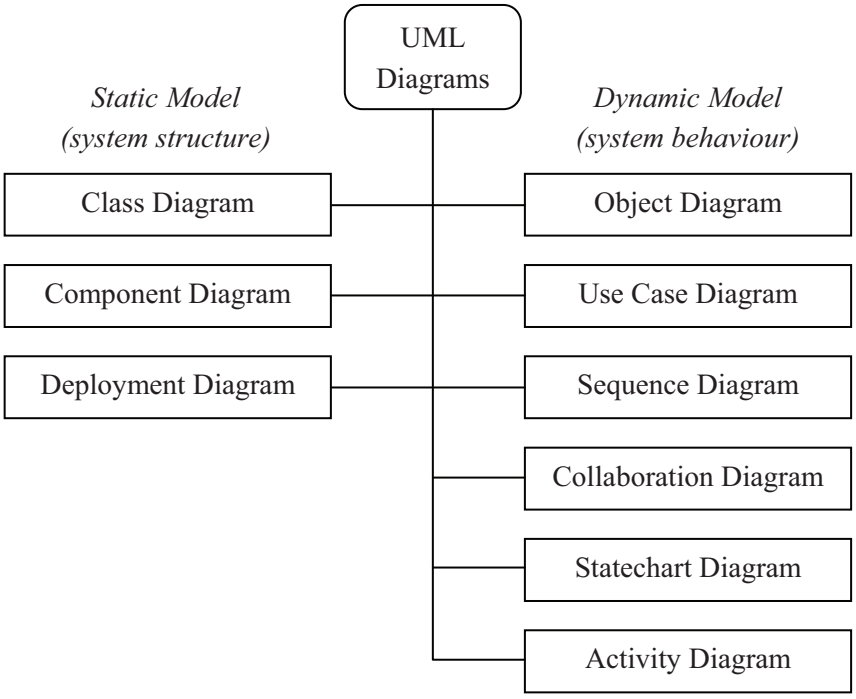

Figure 1. Types of UML Diagram

UML has four common mechanisms that apply consistently throughout the language. They describe four strategies for approaching object modelling which are applied again and again in different contexts throughout UML. Those mechanisms are: specifications, adornments, common division and extensibility mechanism.

Specifications are textual descriptions of the semantics of an element. UML models have at least two dimensions are graphical dimension that allow visualization of the model using diagram and textual dimension that consists of the specifications of the various modelling elements. The semantics behind modelling elements are captured in their specifications and without these specifications the audience can only guess what a modelling element actually represents.

Adornment is a very nice UML feature. Every modelling element has a very simple symbol, to which may be added a number of adornments when more information is to be shown on a diagram. This means that designer can start by constructing a very high level model by using just the basic symbols with perhaps one or two adornment and then the model can be refined over time by adding more and more adornment.

Common divisions describe particular ways of thinking about the world. There are two common divisions in UML are:

- Classifier and instance, classifier is an abstract notion of a type of thing while instance is a concrete things.
- Interface and implementation, interface defines a contract that specifies the behaviour of a thing while implementation is the specific details of how the things work.

Extensibility mechanism of UML consists of constraints, stereotypes and tagged value. Constraints extend the semantics of an element by adding new rules. A stereotype allows a designer to define a

new UML modelling element based on an existing modelling element. Stereotype can be shown by guillemots («stereotype»). Tagged allow designer to add new ad hoc information to modelling element. Tagged value is indicated by curly bracket ({tag=value, tag=value}).

Class Notation

(Rumbaugh et al., 2004) define class as the descriptor for a set of object that shares the same attributes, operations, methods, relationships and behaviour. The visual UML syntax is very rich but the only mandatory part is the name of compartment with class name. The complete class notation consists of three compartments as depicted in figure:

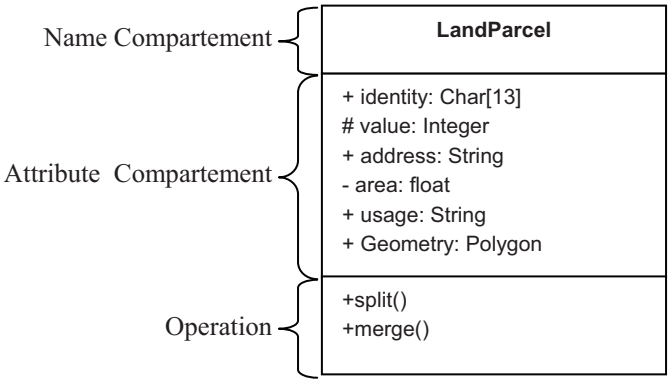

Figure 2. Class Notation

Name Compartment

UML does not mandate naming convention for classes. But here is some guide on how to write class name:

1. Class name can be camel case or title case and usually singular.
2. The usage of special symbol such as punctuation mark, dashes, underscore, ampersand, hashes and slashes should be avoided.
3. Avoid abbreviating class name.

Complete visual syntax of name compartment may look like:

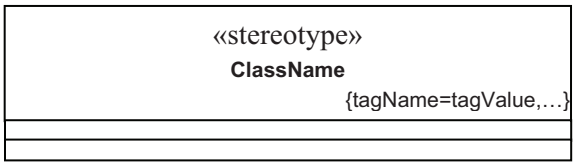

Figure 3. Complete Visual Syntax of Name Compartment

Attribute Compartment

Attribute name is the only mandatory part of UML attribute syntax. The complete visual syntax may look as follow:

visibility name multiplicity : type = initialValue

The visibility adornment applies to attributes and operations within the class. The visibility adornment is shown bellow:

Adornment	Visibility Scope	Semantics
+	Public	Any element can access the class can access any of its features with public visibility
-	Private	Only operations within the class can access features with private visibility
#	Protected	Only operations within the class, or within children of the class, can access features with protected visibility
~	Package	Any element that is in the same package as the class, or in the nested sub package, can access any of its features with package visibility

Multiplicity allows to model two distinctly different things by using a multiplicity expression (Arlow and Neustadt, 2005):

1. Array – if the multiplicity expression results in an integer greater than one.
2. Null values – null object mean that the value has not been yet created or has ceased to exist.

Multiplicity expression can be defined as follow:

- address[3] : String, mean that the address is composed by three array of string.
- name[2..*]: String, mean that the name is composed at least by two array of string or more.
- Email[0..1]: String, mean that email attribute is composed by one string or null.

Attributes can be extended by prefixing them with stereotypes to indicate special semantics or by give postfixes to the attribute with tagged values. It can be described as follow:

«stereotype» attribute {tag1 = value1, tag2 = value2, …}

Operation Compartment

Operations are functions that are tied to a class. Operations have all characteristic of functions are function name, parameter list, and return type. The complete visual syntax for operation is:

visibility name (parameterName : parameterType, …) : returnType

Despite of operation, constraint can be placed in operation compartment as well. Constraints represent restrictions placed on an element. They may be natural language or use a formal grammar such as the Object Constraint Language (OCL). However, they must evaluate to a boolean expression. Constraints typically are shown between curly braces ({}) after the element they restrict, though they may be placed in a note and linked to the element using a dashed line.

Abstract Class

An abstract class is typically a class that provides an operation signature, but no implementation; however, you can have an abstract class that has no operations at all. An abstract class is useful for identifying common functionality across several types of objects. For example, you can have an

abstract class named Movable. A Movable object has a current position and the ability to move somewhere else using an operation named move( ). There can be several specializations of this abstract class a Car, a Grasshopper, and a Person, each of which provides a different implementation of move( ). Because the base class Movable doesn't have an implementation for move( ), the class is said to be abstract. An abstract class can't be instantiated; it must be subclassed and then a subclass which does provide the operation implementation can be instantiated. An abstract class is shown by italic font. In some cases, abstract class is indicated by a tag { abstract }.

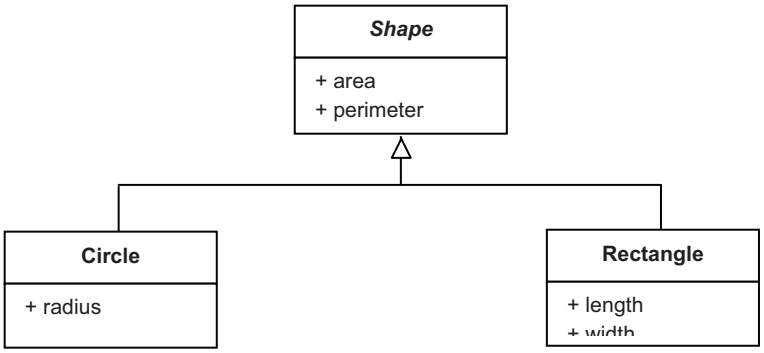

Figure 4. Abstract Class

Interface

Class and an interface differ: A class can have an actual instance of its type, whereas an interface must have at least one class to implement it. In UML 2, an interface is considered to be a specialization of a class modelling element. Therefore, an interface is drawn just like a class, but the top compartment of the rectangle also has the text "«interface»".

Association Syntax

(Rumbaugh, 2004) define association as semantic relationship between two or more classifiers that involves connections among their instances. Association may have association name, role names, multiplicity and navigability.

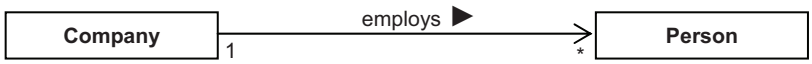

Figure 5. Association Name

Association names should be verbs or verb phrases that indicate the semantics of the associations. Instead of association name, role name can be used.

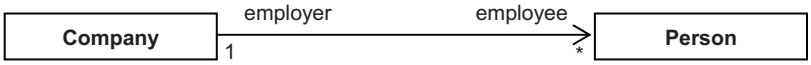

Figure 6. Role Name

Role names should be nouns or noun phrases as they name a role that object can play. The multiplicity of an association end is the number of possible instances of the class associated with a single instance of the other end. Multiplicities are single numbers or ranges of numbers. In the example, there can be only one employer for each employee, but an employer can have any number of employees. A navigability arrow on an association shows which direction the association can be traversed or queried. An employer can be queried about its employee, but not the other way around. The arrow tells who "owns" the association's implementation; in this case, Company has some employee. Associations with no navigability arrows are bi-directional.

Association Class

In modelling an association, sometimes there are requirements to include valuable information about the relationship. In this case, association class that is tied to the primary association can be used. An association class is represented like a normal class. The difference is that the association line between the primary classes intersects a dotted line connected to the association class. Figure 10 shows an association class.

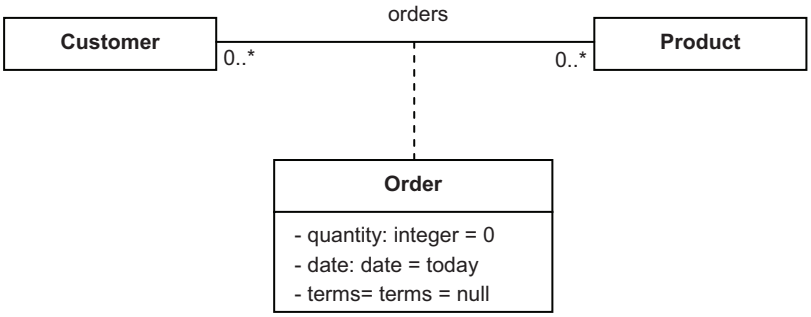

Figure 7. Association Class

Aggregation Association

An association with an aggregation relationship indicates that one class is a part of another class. In an aggregation relationship, the child class instance can outlive its parent class. To represent an aggregation relationship, you draw a solid line from the parent class to the part class, and draw an unfilled diamond shape on the parent class's association end. Figure 11 shows an example of an aggregation relationship between a Car and a Wheel.

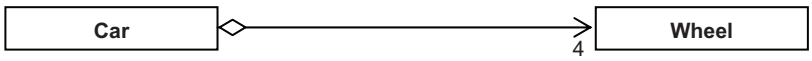

Figure 8. Aggregation

Composition Association

The composition aggregation relationship is just another form of the aggregation relationship, but the child class's instance lifecycle is dependent on the parent class's instance lifecycle. In Figure 12, which shows a composition relationship between a Company class and a Department class, notice that the composition relationship is drawn like the aggregation relationship, but this time the diamond shape is filled.

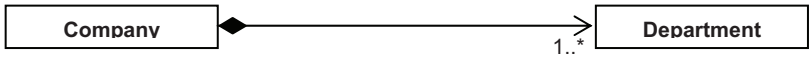

Figure 9. Composition

Generalization Association

Generalization association is an association in which one model element (child) is based on another model element (parent). The parent class can have one or more children, and any child class can have one or more parents. It is more common to have a single parent model element and multiple child model elements. Generalization relationships do not have names and multiplicity.

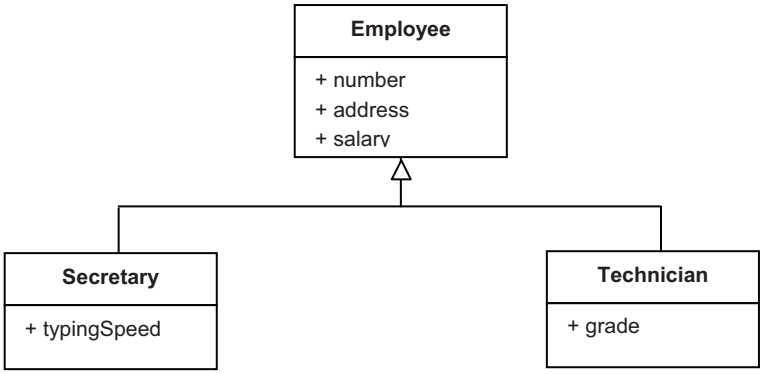

Figure 10. Generalization

Materialization Association

Materialization better modelled as a special 1:N association between child and parent. It allows attributes in the child class to derive attributes from parent class.

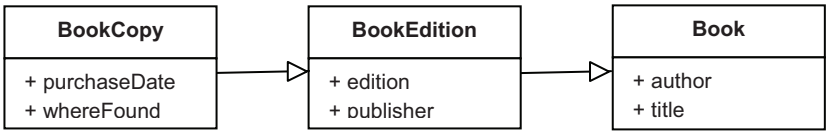

Figure 11. Materialization

Reflexive Association

A class can also be associated with itself, using a reflexive association. This may not make sense at first, but remember that classes are abstractions. Figure 15 shows how an Employee class could be related to itself through the supervisor/subordinate role.

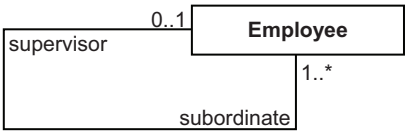

Figure 12. Reflexive Association

Package

A package provides the ability to group together classes and/or interfaces that are either similar in nature or related. Grouping these design elements in a package element provides for better readability of class diagrams, especially complex class diagrams. Package is represented as a tabbed folder or frame as depicted in figure 16. A package can also have relationships with other packages similar to relationships between classes and interfaces.

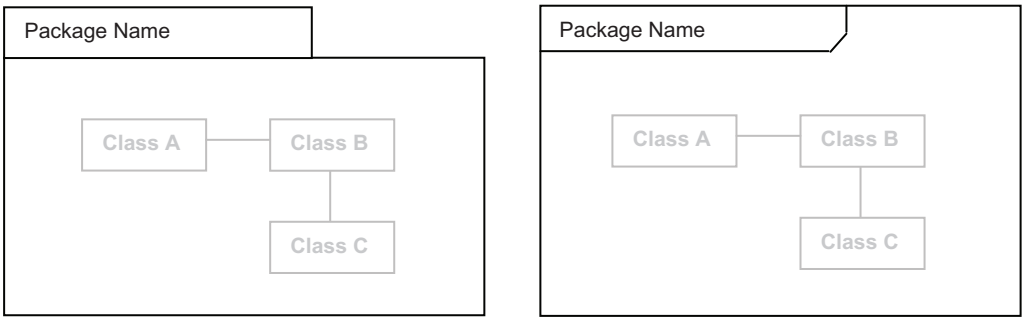

Figure 13. UML Package

Appendix 2: Topology Creation in PostGIS 1.3.3

Here are steps to enabling topology support in PostGIS:

1. Define spatial reference system. BPN utilize TM3 coordinate system. In general, Indonesian territory covered by 16 zone of TM3 and Central Jakarta municipal located on 48.2 zone. TM3 coordinate system actually is not supported by PostGIS coordinate system. PostGIS coordinate system refer to EPSG coordinate system dataset. According to version 6.13 of EPSG coordinate system released on May 2007, EPSG code for 48.2 zone is 23834. Hence, the SQL syntax to insert zone 48.2 coordinate system could be:

```
insert into spatial_ref_sys values (23834,'EPSG',23834,'PROJCS["DGN95 /
Indonesia TM-3 zone 48.2",
GEOGCS["DGN95",DATUM["Datum_Geodesi_Nasional_1995", SPHEROID["WGS 84",
6378137,298.257223563, AUTHORITY["EPSG","7030"]],
TOWGS84[0,0,0,0,0,0,0], AUTHORITY["EPSG","6755"]],PRIMEM["Greenwich",0,
AUTHORITY["EPSG","8901"]],
UNIT["degree",0.01745329251994328,AUTHORITY["EPSG","9122"]],
AUTHORITY["EPSG","4755"]],PROJECTION["Transverse_Mercator"],
PARAMETER["latitude_of_origin",0], PARAMETER["central_meridian",106.5],
PARAMETER["scale_factor",0.9999], PARAMETER["false_easting",200000],
PARAMETER["false_northing",1500000],
UNIT["metre",1,AUTHORITY["EPSG","9001"]], AUTHORITY["EPSG","23834"]]',
'+proj=tmerc +lat_0=0 +lon_0=106.5 +k=0.9999 +x_0=200000 +y_0=1500000
+ellps=WGS84 +units=m +no_defs ');
```

2. Create a buffer table that holds raw faces information (from DGW files). This data originated from ACAD_CNTR table in cad file. The data definition language for this table is:

```
CREATE TABLE ACAD_FACE
(
gid serial NOT NULL,
id integer NOT NULL,
nib character varying(14) NOT NULL,
filename character varying(50) NOT NULL,
CONSTRAINT acad_face_gid_pkey PRIMARY KEY (gid)
)
WITHOUT OIDS;
ALTER TABLE ACAD_FACE OWNER TO postgres;
```

   The records populated from SQL file which is produced by a small auto-lisp program that is ran in autocad map environment.

3. Create a buffer table that holds raw edges information (from DWG file). This data originated from ACAD_EDGE table in cad file. The data definition language for this table is:

```
CREATE TABLE ACAD_EDGE
```

```
(
gid serial NOT NULL,
leftface integer NOT NULL,
rightface integer NOT NULL,
filename character varying(50) NOT NULL,
CONSTRAINT acad_edge_gid_pkey PRIMARY KEY (gid)
)
WITHOUT OIDS;
ALTER TABLE ACAD_EDGE OWNER TO postgres;
SELECT
AddGeometryColumn('public','acad_edge','geom','23834','LINESTRING',2);
```

The records populated from SQL file which is produced by a small auto-lisp program that is ran in autocad map environment.

4. The next step is enabling topology module. Enabling topology module can be done by execute C:\Program Files\PostgreSQL\8.2\share\contrib\postgis\topology.sql. The SQL will create a schema named topology. Under topology schema there will be two tables are layer and topology. This schema also provides some functions to manage topological data.

5. After topology.sql executed, creation of topology data-model can be done. To create topology, execute following SQL:

```
SELECT topology.CreateTopology('kadaster',4326,0.000005);
```

The SQL will create a new schema named kadaster consists of four tables are edge_data, face, node and relation.

6. Insert face records from acad_face table. Here is SQL command:

```
INSERT INTO kadaster.face SELECT gid,NULL FROM acad_face WHERE gid > 0
ORDER BY gid;
```

The SQL above will leave the MBR field without value. The value will be updated later as described in step 10.

7. Insert node records derived from acad_edge table. Here is SQL command:

```
BEGIN;
INSERT INTO kadaster.node SELECT c1, NULL, c2 FROM
(SELECT nextval('kadaster.node_node_id_seq') as c1, * FROM (SELECT
endpoint(geom) as c2
  FROM kadaster.edge_data
 UNION
SELECT startpoint(geom) as c2
  FROM kadaster.edge_data) as tbl1) as tbl2;
END;
```

8. Insert edge_data records from acad_edge table. A tricky action is needed to allow null value on start_node, end_node, next_left_edge, abs_next_left_edge, next_right_edge, and abs_next_right_edge field in edge_data table. Values on those fields can be calculated later by creating PL/PGSQL functions. Here is SQL command:

```
BEGIN;
INSERT INTO kadaster.edge_data
(SELECT egid1,NULL,NULL,NULL,NULL,NULL,NULL,fgid1,fgid2,geom FROM
(SELECT e.gid as egid1, f.gid as fgid1, f.id as fid2, e.leftface
   FROM acad_edge e LEFT JOIN acad_face f ON e.leftface = f.id) as t1
LEFT JOIN
(SELECT e.gid as egid2, f.gid as fgid2, f.id as fid2, e.rightface,
e.geom
   FROM acad_edge e LEFT JOIN acad_face f ON e.rightface = f.id) as t2
ON t1.egid1 = t2.egid2 order by egid1);
END;
```

9. Update some field in edge_data table are start_node,end_node, next_left_edge and next_right_edge. I created some functions that return start_node, end_node, next_left_edge and next_right_edge from given gid. Here is a single SQL to update those fields:

```
--Fill start_node & end_node
UPDATE kadaster.edge_data e set start_node = (SELECT node_id FROM
kadaster.node n WHERE EQUALS(n.geom,startpoint(e.geom)) AND n.geom &&
e.geom ORDER BY edge_id);
UPDATE kadaster.edge_data e set end_node = (SELECT node_id FROM
kadaster.node n WHERE EQUALS(n.geom,endpoint(e.geom)) AND n.geom &&
e.geom ORDER BY edge_id);
--Fill next_left_edge & next_right_edge
UPDATE kadaster.edge_data e SET next_left_edge = (SELECT
kadaster.getnextleftedge(e.edge_id)), next_right_edge = (SELECT
kadaster.getnextrightedge(e.edge_id));
--Fill abs_next_left_edge & abs_next_right_edge
UPDATE kadaster.edge_data e SET abs_next_left_edge =
abs(e.next_left_edge), abs_next_right_edge = abs(e.next_right_edge);
```

10. Update MBR from face records. Use the following SQL to update MBR field:

```
UPDATE kadaster.face f SET mbr = (SELECT
ST_box2d(topology.geometry(p.feature)) FROM public.registerpersil p
WHERE f.face_id = p.gid AND f.face_id > 0);
```

11. Add topogeometrycolum to registerparcel table.

```
select topology.AddTopoGeometryColumn('kadaster', 'public',
'REGISTERPARCEL', 'FEATURE', 'POLYGON', NULL);
```

12. Insert registerparcel record. The value for the topogeometrycolumn is constructed as follow:

```
topology.CreateTopoGeom(
            topology_name,
            feature_type,   -- 1:(multi)point, 2:(multi)line,
                            -- 3:(multi)poly, 4:collection
```

```
                layer_id,       -- as returned by AddTopoGeometryColumn
                TopoElementArray
        );
```

The TopoElementArray type is a domain defined by the PostGIS Topology module. It is defined as a bidimensional array of integers. For Basic TopoGeometry objects this would be: {{element_type, element_id}, ...}. For example:
`topology.CreateTopoGeom('kadaster',3,2,'{{1,3}}')`
will create a topogeometry column that consist of a single face with id = 1. If we want topogeometry column consist of two face, than the syntax should be
`topology.CreateTopoGeom('kadaster',3,2,'{{3,3},{4,3}}'));`

13. Create view (area of interest):

```
CREATE OR REPLACE VIEW areaofinterest AS
SELECT rp.gid, rp.identity AS parcel_identity, rp.address, rp.use,
r."share", r."type", r.identity AS right_identity, substring(r.identity
from 10 for 1) AS righttype, r.beginvalidityversion,
r.endvalidityversion, topology.geometry(rp.feature) AS geom
  FROM registerparcel rp, "right" r
 WHERE r.registerparcelgid = rp.gid
   AND (rp.feature).id in (SELECT face_id FROM kadaster.face WHERE
intersects(mbr, GeomFromText('POLYGON((236242 814274, 236242 814773,
237045 814773, 237045 814274, 236242 814274))',-1)));
ALTER TABLE areaofinterest OWNER TO postgres;
```

To visualize, create custom projection in qgis called TM3-48.2 with parameter as follow:
`+proj=tmerc +lat_0=0 +lon_0=106.5 +k=0.9999 +x_0=200000 +y_0=1500000 +ellps=WGS84 +units=m +no_defs`

Function to Get Next Edge

```
-- Function: kadaster.getnextleftedge(integer)
-- DROP FUNCTION kadaster.getnextleftedge(integer);
CREATE OR REPLACE FUNCTION kadaster.getnextleftedge(integer)
  RETURNS integer AS
$BODY$
DECLARE
       ei ALIAS FOR $1;
       --snode integer;
       enode integer;
       nle_id integer;
       rec RECORD;
BEGIN
       SELECT e.end_node INTO enode FROM kadaster.edge_data e WHERE
e.edge_id = ei;

       nle_id = ei;
       FOR rec IN EXECUTE 'SELECT e2.* FROM kadaster.edge_data e1,
kadaster.edge_data e2 WHERE e1.edge_id = ' || ei || ' AND TOUCHES(e1.geom,
e2.geom) AND e1.geom && e2.geom AND (e2.left_face = e1.left_face OR
```

```
e2.right_face = e1.left_face) AND (e2.start_node = ' || enode || ' OR
e2.end_node = ' || enode || ');'
	LOOP
		IF rec.start_node = enode THEN
			nle_id = rec.edge_id;
		ELSE
			nle_id = (rec.edge_id * -1);
		END IF;
	END LOOP;

	return nle_id;
END
$BODY$
  LANGUAGE 'plpgsql' VOLATILE;
ALTER FUNCTION kadaster.getnextleftedge(integer) OWNER TO postgres;


-- Function: kadaster.getnextrightedge(integer)
-- DROP FUNCTION kadaster.getnextrightedge(integer);
CREATE OR REPLACE FUNCTION kadaster.getnextrightedge(integer)
  RETURNS integer AS
$BODY$
DECLARE
	ei ALIAS FOR $1;
	snode integer;
	--enode integer;
	nle_id integer;
	rec RECORD;
BEGIN
	SELECT e.start_node INTO snode FROM kadaster.edge_data e WHERE
e.edge_id = ei;

	nle_id = ei * -1;
	FOR rec IN EXECUTE 'SELECT e2.* FROM kadaster.edge_data e1,
kadaster.edge_data e2 WHERE e1.edge_id = ' || ei || ' AND TOUCHES(e1.geom,
e2.geom) AND e1.geom && e2.geom AND (e2.left_face = e1.right_face OR
e2.right_face = e1.right_face) AND (e2.start_node = ' || snode || ' OR
e2.end_node = ' || snode || ');'
	LOOP
		IF rec.start_node = snode THEN
			nle_id = rec.edge_id;
		ELSE
			nle_id = (rec.edge_id * -1);
		END IF;
	END LOOP;

	return nle_id;
END
$BODY$
  LANGUAGE 'plpgsql' VOLATILE;
ALTER FUNCTION kadaster.getnextrightedge(integer) OWNER TO postgres;
```