ADOPTION OF LAND ADMINISTRATION DOMAIN MODEL FOR LAND ADMINISTRATION IN MALAYSIA

NUR AMALINA BINTI ZULKIFLI

UNIVERSITI TEKNOLOGI MALAYSIA

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NUR AMALINA ZULKIFLI

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requirements for the award of the degree of
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Dedicated to my parents

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ABSTRACT

Land administration is a process of recording and disseminating information about the association between people and land. To administer land matters in Malaysia, the Department of Surveying and Mapping Malaysia uses *eKadaster* and Land Office has *eTanah* which are different e-systems. Currently, Malaysia does not have a standard model for land administration and standardisation is one of the important aspects in a land administration process. This research proposed a country profile model using international standards based on Land Administration Domain Model. This research also attempted to generate strata object model via Land Administration Domain Model which would be useful for Malaysia and countries with similar land administration systems. In this proposed model, spatial data modelling using secondary data from the aforementioned two land administration units in Malaysia and Unified Modelling Language application were used to develop the conceptual and the technical models. The developed model was evaluated and verified by the Department of Surveying and Mapping Malaysia and Land Office. These units agreed and were satisfied because the model fits their requirements by being more comprehensive as it included three-dimensional lots and two-dimensional topology. In addition, the proposed model facilitated the management of spatial and non spatial objects such as customary areas, reserved lands, lots, strata objects, utilities and the related attributes to be better managed by the two units. The development of Malaysian Land Administration Domain Model country profile is unique because it can support a very wide range of spatial units. Besides that, the profile included the contents of the various code lists as they are important aspects of standardisation. Furthermore, the model was developed to help establish a national Spatial Data Infrastructure or Malaysian Information Infrastructure. To conclude, the developed Malaysian Land Administration Domain Model is a standardised model that could be used for local and international exchange of information concerning land administration matters.

ABSTRAK

Pentadbiran tanah adalah satu proses merekod dan menyebarkan maklumat mengenai hubungan manusia dan tanah. Bagi mentadbir urusan tanah di Malaysia, Jabatan Ukur dan Pemetaan Malaysia menggunakan *eKadaster* dan Pejabat Tanah mempunyai *eTanah* yang merupakan e-sistem berbeza. Pada masa kini, Malaysia tidak mempunyai model piawaian untuk pentadbiran tanah dan pemiawaian merupakan salah satu aspek penting dalam proses pentadbiran tanah. Kajian ini mencadangkan model profil negara menggunakan piawaian antarabangsa berdasarkan Model Bidang Pentadbiran Tanah. Kajian ini juga cuba untuk menghasilkan model objek strata menggunakan Model Bidang Pentadbiran Tanah yang mana akan berguna untuk Malaysia dan negara-negara dengan sistem pentadbiran tanah yang sama. Dalam model yang dicadangkan ini, pemodelan data spatial menggunakan data sekunder daripada kedua-dua unit pentadbiran tanah di Malaysia yang dinyatakan di atas dan aplikasi Bahasa Pemodelan Bersepadu telah digunakan untuk membangunkan model konsep dan teknikal. Model yang dibangunkan telah dinilai dan disahkan oleh Jabatan Ukur dan Pemetaan Malaysia dan Pejabat Tanah. Unit- unit ini bersetuju dan berpuas hati kerana model tersebut memenuhi keperluan mereka dengan menjadi lebih menyeluruh kerana ia disertakan lot tiga-dimensi dan topologi dua-dimensi. Di samping itu, model yang dicadangkan memudahkan pengurusan objek spatial dan bukan spatial seperti kawasan adat, tanah rizab, lot, objek strata, utiliti dan atribut yang berkaitan untuk diuruskan dengan lebih baik oleh kedua-dua unit. Pembangunan profil negara Model Bidang Pentadbiran Tanah Malaysia adalah unik kerana ia dapat menyokong unit spatial lingkungan yang sangat luas. Selain daripada itu, profil tersebut merangkumi kandungan senarai kod yang pelbagai kerana ia adalah aspek penting bagi pemiawaian. Seterusnya, model yang telah dibangunkan membantu untuk menubuhkan Infrastruktur Data Spatial negara atau Infrastruktur Maklumat Malaysia. Kesimpulanya, Model Bidang Pentadbiran Tanah Malaysia yang dibangunkan adalah model piawaian yang boleh digunakan untuk petukaran maklumat berkaitan perkara pentadbiran tanah tempatan dan antarabangsa.

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LIST OF ABBREVIATIONS

2D	-	Two-Dimensional
3D	-	Three-Dimensional
CCDM	-	Core Cadastral Domain Model
CEN	-	Committee European of Normalisation
CD	-	Committee Draft
CLIS	-	Cyprus Land Information System
CRS	-	Coordinate Reference System
DBMS	-	Data Base Management System
DIS	-	Draft International Standard
DQ	-	Data Quality
DSMM	-	Department Survey and Mapping Malaysia
EU	-	European Union
FAO	-	Food and Agricultural Organization
FDIS	-	Final Draft International Standard
FIG	-	International Federation of Surveyor
GIS	-	Geographical Information System
GLTN	-	Global Land Tool Network
GM	-	Geometry
GPS	-	Global Positioning System
ICT	-	Information and Communication Technology
INSPIRE	-	Infrastructure for Spatial Information
ISO	-	International Organization for Standardization
ITC	-	Faculty of Geo-Information Science and Earth Observation
LA	-	Land Administration
LADM	-	Land Administration Domain Model
LAS	-	Land Administration System

LIS	-	Land Information System
LPIS	-	Land Parcel Identification System
MD	-	Meta Data
MDA	-	Model Driven Architecture
NDCDB	-	National Digital Cadastral Database
OCL	-	Object Constraint Language
OGC	-	Open Geospatial Consortium
OM	-	Observations and Measurements
RRR	-	Rights, Restrictions, Responsibilities
SDI	-	Spatial Data Infrastructure
STDM	-	Social Tenure Domain Model
TC	-	Technical Committee
UML	-	Unified Modelling Language
UN	-	United Nations
UNECE	-	United Nations Economic Commission for Europe
UPI	-	Unique Parcel Identifier
UTM	-	Universiti Teknologi Malaysia
WD	-	Working Draft
XML	-	Extensible Markup Language

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CHAPTER 1

INTRODUCTION

1.1 Introduction

With increasing urban population, urban space is limited, hence urban exploitation and utilization is carried out considering a careful plan for the urban area. A land lot can have multi-level constructions such as condominiums belonging to different owners. Most traditional cadastral systems are based on two-dimensional (2D) registration which deals with geometry and semantics of land lots on the land surface. These systems have some difficulties in dealing with today's multi-level reality. Although the traditional 2D cadastre still plays a dominant role in land administration in Malaysia, specific needs for the registration related to 3D cadastre based on Land Administration Domain Model (LADM) specifications need further investigation.

LADM is an important model to create standardized information services in an international context, where land administration domain semantics have to be shared between regions, or countries, in order to enable necessary translations. There are many different reasons to adopt International Organization for Standardization (ISO) 19152, LADM:

i. contains the collective experience of experts from many countries (within ISO and International Federation of Surveyor (FIG);

ii. takes long time to develop by FIG/ISO committee, but LADM is based on consensus and now adopted by ISO and Committee European of Normalisation (CEN);

iii. allows meaningful exchange of data (within country, Spatial Data Infrastructure (SDI) setting, but also between countries);

iv. covers complete land administration spectrum: survey, cadastral maps, rights, restrictions, responsibilities, mortgages, persons (individuals of groups), etc.;

v. allows integrated 2D and 3D representation of spatial units;

vi. supports both formal and informal Rights, Restrictions and Responsibilities (RRRs); and

vii. links essential land information data to source documents, both spatial (survey) and legal (title, deed).

Literature shows that many countries propose their own profile based on LADM such as Portugal, Korea, Japan, The Netherlands, Australia/Queensland, Cyprus and others. Malaysia is one of the potential candidates towards LADM-based country profile. As listed in ISO 19152 (2012), two important goals of this model are:

i. to give a foundation for the refinement and development of effective land administration system, using a Model Driven Architecture (MDA),
ii. to involve parties, within one country and different countries, to communicate based on the same terminologies, used by the model.

The process of recording and disseminating information about the association between people and land is called land administration. A land tenure is about the ownership as the mechanism through which rights to land are held. The most important thing of land tenure is that it reflect a social relationship between people

and land is recognized as a lawfully valid one, either formal or informal. These rights are qualified for registration, with the aim to assign a particular legal meaning to the registered right. Hence, land administration systems are not just managing land information, but also represent legally meaningful relationship between land and people.

Land administration deals with large amounts of data, which furthermore can become dynamic. It also needs an endless maintenance process, therefore the function of Information and Communications Technology (ICT) is important. It will be difficult to guarantee good archival processing to meet customer requires without the availability of information systems. Organizations are progressively faced with rapid growth in technology, also with rising request for new services. Modelling is a basic tool facilitating applicable system development. Besides, it creates the basis for a significant communication between different systems.

Standardizations have become well known in land administration process. Standards are required to specify objects, relationships between persons and objects, objects representation, classification of land use, land value and transactions. Computerized systems need to further standardization to identify the single boundaries and topologies. Currently, standardization is only limited to the jurisdiction of region, where the land administration is in operation.

This research describes the conceptual model of the Land Administration Domain Model (LADM), in particular the parties, the rights, restrictions and responsibilities (RRRs) and the relationship with spatial data in 2D and 3D Cadastral. LADM provides an abstract model to build concrete application including 2D and 3D cadastral model.

1.2 Problem Statement

Land administration system has been developed by a number of countries by their own systems (Bogaerts and Zevenbergen, 2001). Basically, two main functions

of every land administration is keeping the contents of these relationships up-to-date and providing information from the register.

Peninsular Malaysia is a federation of states, each of which is responsible for its own land matters. All states operate a Torrens system of registration, administered by the State Land Offices and coordinated by the Department of Land and Mines. However, cadastral surveys are controlled by the Department of Survey and Mapping Malaysia that is a federal department. The cadastre in the states of Sabah and Sarawak are administered by the Department of Land and Surveys. They have the ideal set up of having land administration and cadastral surveys under the control of a single organization, which is a state entity. Therefore, there are centralized (East Malaysia – Sabah and Sarawak) and decentralized (Peninsular Malaysia) land administration systems practiced in Malaysia.

The current Malaysian cadastral registration system does not include three-dimensional objects registration rights. This type of cadastral system has been practiced in Malaysia for a period of one hundred years and it provides essential information about land and property like ownerships of the lots and land parcels for the country. To cater both above and below surface cadastral objects and to enable the registration of real properties that are not limited to the land surface, it is needed to propose a new cadastral system. A three-dimensional (3D) approach for cadastral system and land registration system can provide a better means to manage modern cadastral objects. In addition, *eKadaster* (in DSMM) and *eTanah* (in Land Office) systems still work separately. Consequently, there are no three-dimensional property rights as well as 3D cadastral rights. However, these two systems later on can be incorporated in the registration form with the present advanced and modern technologies such as geographical information system, internet web based and e-commerce applications (van Oosterom, 2013; Jamil, 2013; Abdul Rahman, 2013; Chan, 2013; Teng, 2013)

Currently, in most urban areas, land lots or parcel ownership are becoming more complex due to buildings or condominium, having multiple owners this making the registration of such buildings a difficult task. The geometric representation of

such land based objects are also difficult to achieve. Standardization of land administration within a country should meet international standards, which will hasten land transaction between international entities. This research aims at presenting the concepts of LADM for the Malaysian LADM country profile to harmonize 2D and 3D land registration in Malaysia.

Pouliot et al, (2011) introduced LADM profile for Quebec condominium units (Figure 1.1) and LADM profile for French condominium units (Figure 1.2) to make some analysis comparison. From both conceptual model of LADM, they are still having lack of information and not comprehensive enough for the registration purposes. The situation shows that this particular research direction needs to be explored further for the same situation in Malaysia (van Oosterom, 2013).

Based on Figure 1.1, LADM layout of Quebec vertical divided co-ownership focus on the LADM packages Spatial Units and Survey & Spatial representation. BAUnit that corresponds to the lot is refined into two specializations Private Parts and Common Part. Ground parcel is added because of the concept of vertical cadastre. Survey points are collected with x, y and z coordinates. Spatial representation package is divided into two packages (i.e. vector and raster). The Complementary Plan (CP) are currently built in vector format (file available by the land surveyor firms who did the survey) but delivered to the end users in image format (PDF or TIFF file). Super class Spatial Unit only possesses the CP-number, an important text (label) element to manage the relation with the raster spatial representation associated to it.

Furthermore, Figure 1.2 elaborates LADM layout of French vertical divided co-ownership which shows almost the same content of Quebec except for the dimension of the building which is now 2D. Co-ownership plans when they are available are produced in CAD files. Therefore, only vector spatial representation package is proposed. Buildings and the ground parcel are represented by line strings and no information exists about the volume. Survey points are collected with x and y coordinates.

Current cadastral system in Malaysia still could not answer many 3D situation as mentioned by Hassan and Abdul Rahman (2010), Stoter (2004) and Thomson and Oosterom (2010). This research is to investigate the potential of LADM specifications with respect to 2D and 3D situations. Based on the recent discussions with JUPEM and JKPTG, the country profile based on LADM specifications is inevitable (Lemmen, 2013; Dimopoulou, 2013).

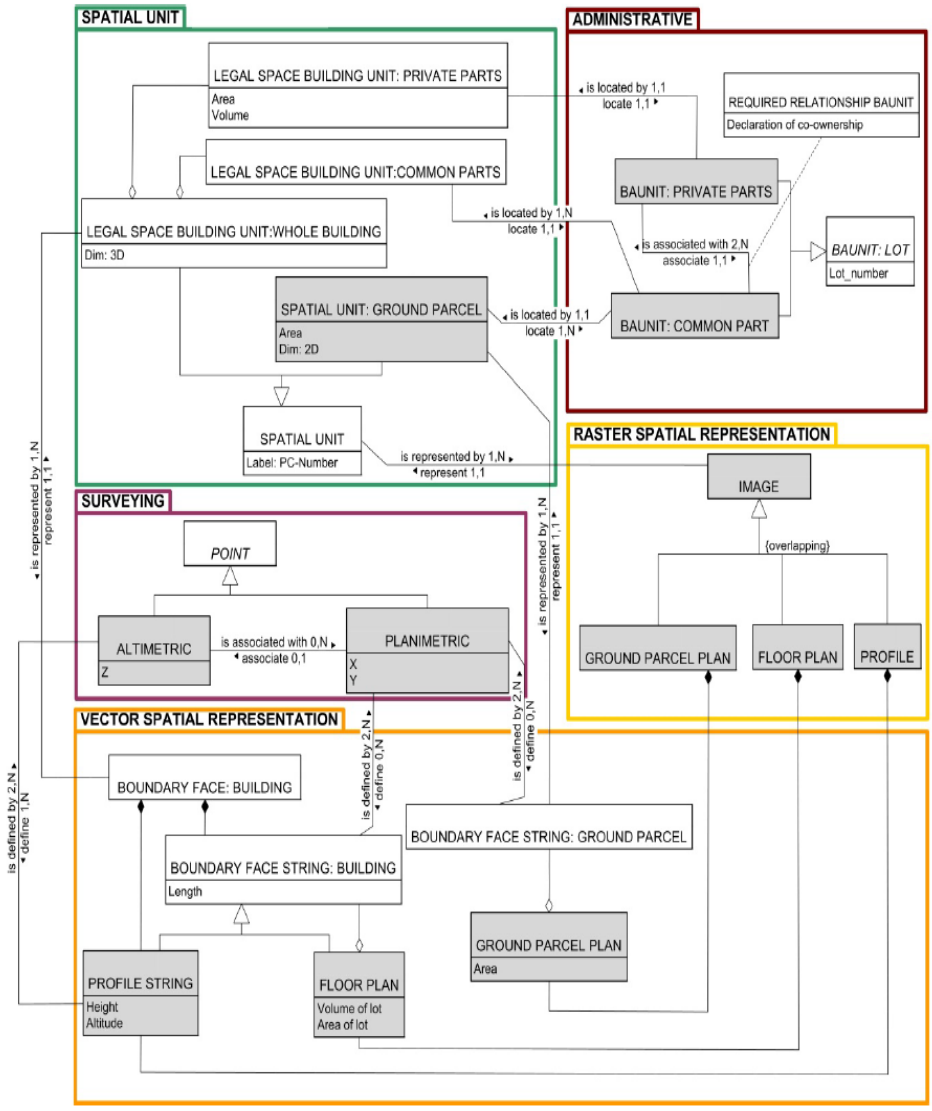

Figure 1.1: LADM profile for Quebec condominium units (Pouliot et al, 2011)

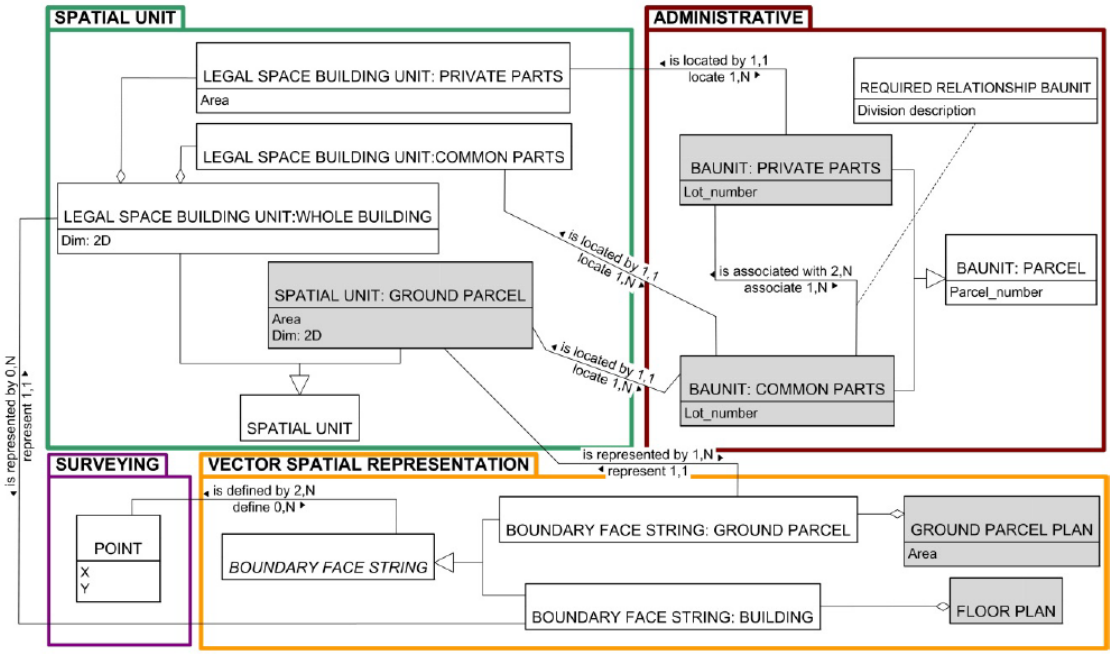

Figure 1.2: LADM profile for French condominium units (Pouliot et al, 2011)

1.3 Research Questions

The following research questions will be addressed:

i. What is a Land Administration Domain Model (LADM)?

ii. How LADM can be utilised for 2D and 3D cadastre objects?

iii. How strata title and the related objects can be mapped within LADM?

iv. How modelling tools such as Unified Modeling Language (UML) works with LADM?

v. How to make use Extensible Markup Language (XML) for integrating the various cadastral objects?

vi. How to design and develop database schema within LADM environment?

1.4 Aim

The aim of this research is to study LADM specifications for 2D and 3D cadastre registration of objects as a framework for establishing LADM – based Malaysian country profile.

1.5 Objectives

The objectives of this research are:

i. To propose a country profile (conceptual model) for 2D and 3D cadastral registration based on LADM specification for Malaysia.

ii. To develop database schema (technical model) for 2D and 3D cadastral registration based on LADM specifications.

1.6 Research Scope

The scope of this research is as follows:

i. There are many tools can be used to develop conceptual model, but in this study, Enterprise Architect (EA) is selected to create UML class diagram.

ii. The organizations involved in this research are;
   - Land Office, and
   - Department Survey and Mapping Malaysia (DSMM)

iii. Type of data;
   - Administrative data which contains ownership of lots (Appendix A) and strata title for building (Appendix B).

- Spatial data which contains National Digital Cadastral Database (NDCDB) model for lots and Strata (Extensible Markup Language) XML model for building. The NDCDB model can be refered to Appendix C, meanwhile Appendix D for the Strata XML model.

iv. This research only focus on conceptual model (country profile) and technical model (database schema) for 2D and 3D cadastral registration in Malaysia

1.7 The Methodology

This section briefly explains the methodology for the research work.

i. Investigate LADM specifications.
ISO 19152 documents are explored to get some information about the LADM. Besides, the current Malaysian cadastral system also needs some revisions.

ii. Investigate LADM case study.
Pouliot, et al (2011) introduced LADM profile for Quebec condominium units to make some analytical comparison. From the conceptual model, there is still lack of information and not comprehensive. Therefore, need some improvements based on Malaysian cadastral system.

iii. Explore and investigate UML class diagram.
LADM use Unified Modelling Language (UML) to come up with conceptual model. Enterprise Architect is one of the tools used to create the UML class diagram in this research.

iv. Data collection
Two types of data are required for this research, administrative and spatial data. Data source for administrative data is collected from the Land Office.

Meanwhile, for spatial data is accessed from the Department Survey and Mapping Malaysia (DSMM). The administrative data contains ownership of lots and strata title for building. The spatial data for this research contains NDCDB model for lots and Strata XML model for building.

v. Exploration of spatial data modelling

LADM consist of many classes such as party, spatial unit, BAUnit and so on. The classes that only related with the research must be finalized. Then, the relevant attribute for each class that has been chosen must be decided. Various relationships of the objects are investigated. Code list also need to be listed for the each code list data type.

vi. Validation of country profile

The proposed Malaysian country profile should be validated with experts dealing with cadastre and land administration system. For example from academic and government administration officers.

vii. Construction of database schema

The Malaysian LADM country profile needs to be translated into a technical model (database schema). It is important to verify the validity of the practical application. Figure 1.3 shows the flow chart (brief) of the research methodology.

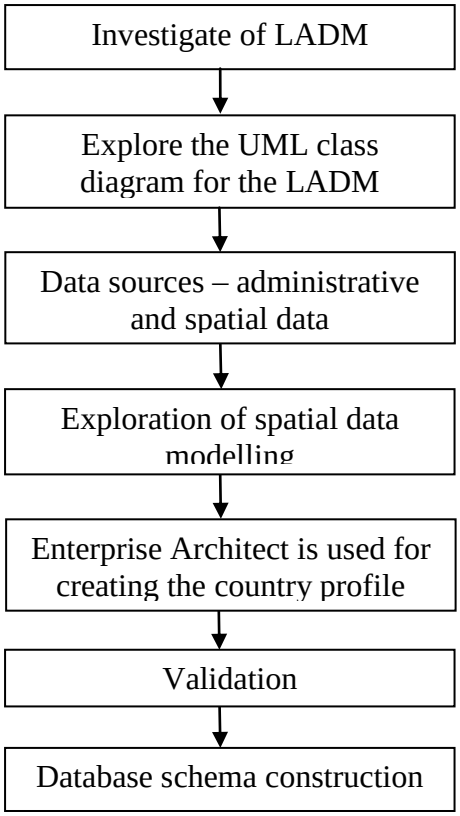

Figure 1.3: Flow chart for research methodology

1.8 Significance of the Research

The significance and contributions of this research are as follows:

i. Enhancement of 2D and 3D cadastral registration in Malaysia.
ii. Towards an integrated Land Office and Department of Survey and Mapping Malaysia (DSMM) system using LADM model.
iii. Establishment of well-defined country profile based on LADM for Malaysia.

1.9 The Structure of the Thesis

Chapter 1 discussses the need for LADM in Malaysian land administration system. The scopes, probems related to the Malaysian land administration system

and the objectives of the research are identified. This chapter also illustrates the flow chart of the research methodology.

Chapter 2 describes the fundamental aspects of LADM. The overview of LADM contains the history and the purpose of LADM are discussed. The packages of LADM (i.e. Party Package, Administration Package, Spatial Unit Package, Surveying and Representation Subpackage) are described. The basic and special classes of LADM are also covered. The relationship and association between the classes in each packages are eloberated. The geometry and topology classes of 2D and 3D spatial unit based on LADM also are included. A review of some country profiles are also presented in this chapter.

Chapter 3 describes the concepts and terms related to spatial data modelling. Spatial data models and their characteristics (i.e. classes, attributes, relationships, constraints and operations) are discussed . The phases in data modelling such as conceptual model, logical model and physical model are described. The conceptual model phase includes the characteristics of Unified Modelling Language (UML) to represent data models. Thus, a short introduction of terms used in UML (i.e. association, generalization, aggregation, composition, multiplicity and association class) are also covered. Three types of logical model (i.e. relational model, object oriented model object relational model are also explained in this chapter.

Chapter 4 describes the conceptual model for the Malaysian LADM country profile. The current cadastral systems and land administration practiced in Malaysia including *eTanah*, *eKadaster* and Strata Title are covered. The development of Malaysian LADM country profile which is divided into two parts (i.e. administrative and spatial part) is described. The aspects of modelling 2D topology and geometry in the proposed country profile are discussed. The types of code lists based on Malaysian LADM country profile are also covered. The model and design decisions on which the model is based also elaborated on this chapter.

Chapter 5 describes the technical model for the Malaysian LADM country profile. Identifier and types of key (i.e. Primary and Secondary Keys) used in this

phase are illustrated. The types of attributes (i.e. constraint, derived and multiplicity attribute) are explained. The terms of relational table, indexing, clustering and 2D topology structure are also described. Finally, the database schema based on Malaysian LADM country profile is presented.

Chapter 6 concludes the findings of the research and proposes a number of recommendations for future research.

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