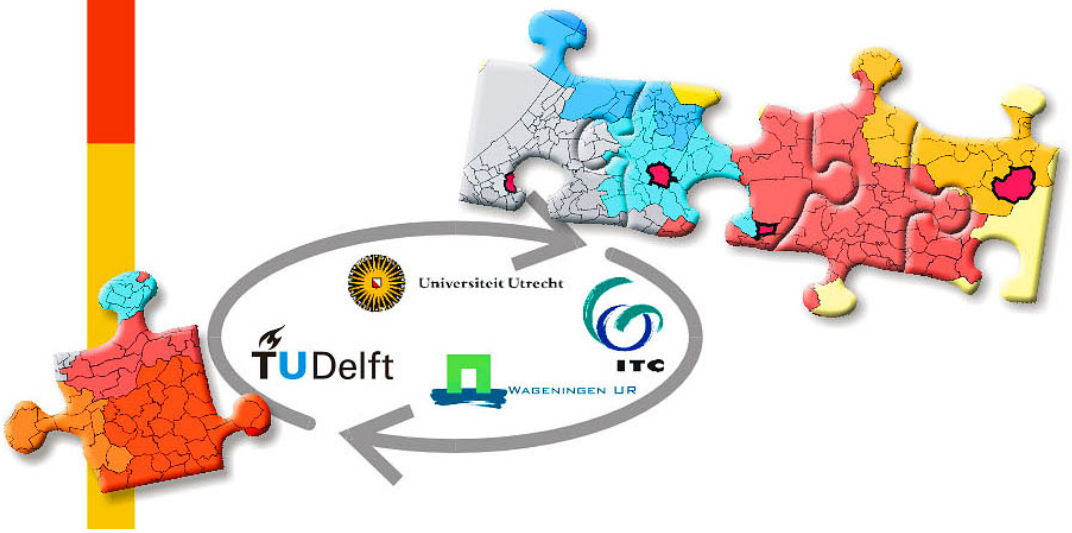
GIMA

Geographical Information Management and Applications

Towards a 3D Cadastre in Malaysia

An Implementation Evaluation

MSc thesis by Chong Seng Chai
September 2006



Acknowledgement

This thesis is based upon my graduation project at the Department of Geo-information and Land Development, OTB Research Institute, Delft University of Technology, the Netherlands. It also marks the end of my Master of Science study in Geographical Information Management and Applications (GIMA). GIMA is jointly organised by University Utrecht, Delft University of Technology, The International Institute for Geo-Information Science and Earth Observation (ITC) and Wageningen University, all from the Netherlands.

I would like to express my sincere gratitude to my supervising professor Jaap Besemer, leading supervisor Hendrik Ploeger (both from Delft University of Technology) and co-supervisor Alias Abdul Rahman (from University of Technology Malaysia). Without their advices and supports this thesis would never had become a reality, in particular Hendrik Ploeger's direction, assistance and guidance have been invaluable for this research.

I would like to thank Jantien Stoter, Peter van Oosterom, Hendrik Ploeger, Moshe Benhamu, Yerach Doytsher and many others whose works on 3D cadastre have been my major source of reference.

I also wish to thank many individuals for their cooperation and help. Tey Boon Kor, Tang Chet Poh and Padzillah Che Ros are thanked for providing me the related material and clarification with respect to the Malaysia cadastre. I would like to thank Arta Dilo for her guidance and for correcting the early proofs. I am also grateful to the staff at OTB Research Institute for their cooperation and assistance.

Special thanks should be given to my student colleagues who helped me in many ways. Finally words alone cannot express the gratitude I owe to my family. To my mom and my late father, for helping to mould me into what I am today. To my wife and my two often home-alone children, for their patience, understanding, continuous support and encouragement.

Chong SC, September 2006.

Abstract

Traditional cadastre is based on division of land into 2D surface parcels, upon which ownership rights are subsequently registered. Nevertheless, the rights to a parcel are always in 3D as land use would be impossible if confined only to the 2D flat surface. However, most 2D registrations are found to be adequate as long as the whole column of space (*cujus est solum ejus est usque ad coelum et ad inferos*) belongs to a person or a ground of persons.

Intensive use of land and technological advances have made it possible to have many different types of uses simultaneously above and below one another. Examples of such multiple use of space (or stratified properties) include the apartment complex, tunnel, utility cable and pipeline criss-crossing under the surface and underground mining. The legal situations in such stratified properties can no longer be portrayed effectively on flat surfaces, as several persons, either as owner(s) or rights or interests holders, now hold the same parcel of land simultaneously. The introduction of the third dimension (hence the so-called 3D cadastre) is deemed necessary in order to provide efficient means to register and to provide the legal status of these factual situations as in the real world.

Cadastre is always related to land. Being an essential tool in administering the man-land relationship, it is continually evolving in response to the dynamic nature of this relationship within the particular society. As a developing nation, the choice of an appropriate Malaysian 3D Cadastre depends upon its local conditions. It should be able to protect land rights effectively, efficiently, simply, securely and affordably.

Keywords: *traditional cadastre, multiple use of space, Malaysian 3D Cadastre.*

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1. INTRODUCTION

There has been a greater awareness that cadastre, being the core component of a land administration system, plays an important role in a modern economy. It supports economic development, social stability and environment management. Traditional cadastral systems are two-dimensional, deal only with property located on the surface. Therefore it is difficult to reflect the spatial aspect of the modern man to land relationship, especially in areas of multilayer use of space. Modern cadastre shall be in 3D as 3D information is becoming critical in registering today's world.

This chapter presents the rationale behind the need for registration of land in three-dimensional space. It begins with a brief introduction on the role of cadastre as the building block of land administration to regulate man's most valuable resource – land. Current land uses are often shared among various landowners, all within the same column of space. This changing man-land relationship brings about the need to evaluate the most appropriate cadastre for Malaysia as it depends on local conditions, first by defining the problem, objective and scope and then outlines on how this research can proceed.

1.1 Overview

Urbanisation and rapid development often led to overlapping and even interlocking constructions. Traditional cadastral systems are two-dimensional, deal with property located on the surface only. The quest is towards how to register these complex stratified properties in the current cadastral registration that registers information on the 2D surface parcels.

Cadastral implementation is always difficult even though its concept is simple. The success of a cadastral system depends not on its legal or technical sophistication, but whether it protects land rights adequately, appropriately, efficiently, simply, quickly, securely and at an affordable level [*53*].

In addressing this need, this research attempts to investigate the feasibility of introducing 3D Cadastre into Malaysia Cadastre, as 3D presentation will permit better definition of cadastral spatial subdivision, which in turn will provide better means for inspection and analysis of data, than the current 2D system.

1.2 Background Information

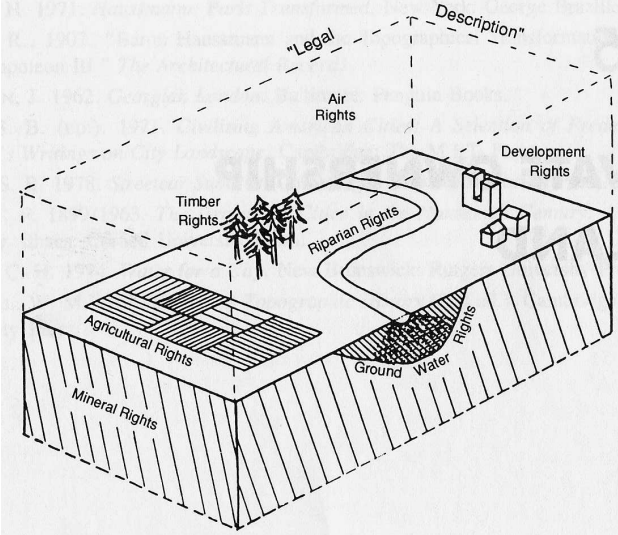
Cadastre always relates to land, basically it deals with man's relationship with the land. As a public land register, it fosters development and economic growth, also as the means of environment management.

1.2.1 Land as a resource

Land is our most valuable resource. It is a physical thing that is not just the surface of the earth but legally includes the subsurface and the air space over the land, and all things attached to it. Yet on the other hand it is also an abstract thing, as the use of land can be traded as a set of rights although land itself is physically immoveable.

In law, land is referred to as real property or realty. Real property includes the land and things attached to it, such as houses; and also the rights a person has over the land. Owning a piece of land includes not only the horizontal land surface, but extends to the middle of the earth and to the heavens.

Fig. 1: Elements of real property rights in land [*38*].



1.2.2 Land ownership

Ownership normally means the rights of an owner to have the exclusive possession and use of something, and to be able to dispose it. Land ownership means owning not only the land itself but an interest in land. It can be described as "*bundle of green and red sticks*". Greens being the rights the owner enjoys in making profitable or pleasurable use of the land, like the right to till the soil, build on the land etc. Reds represent the duties of owner that are necessary to enjoy the green sticks, for example paying property tax. However, there are limits to the extent of ownership. Some are statutory; others are founded on the common laws. In reality, the owner's rights extend only to such a height and depth as is reasonably necessary for the ordinary use and enjoyment of the land, beyond that he has no greater rights than any other member of the public.

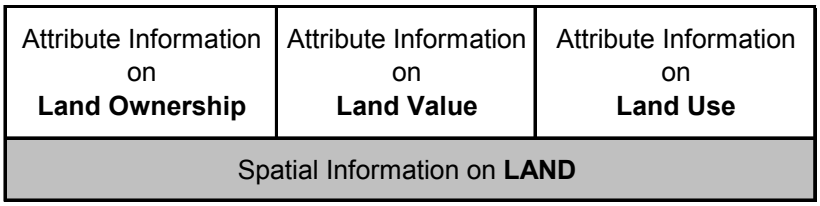
The control over land (ownership) regulates the man-land relationship, thus has great economic, socio-political and even religious implications. Information on '*who*' '*holds*' '*which*' parcel of land is essential to ensure that land is managed sustainably for present and future generations. Access to land and security for credit are both crucial to good land management practice and sustainable development. It is of no wonder that World Bank's report "Doing Business in 2005" included '*registering property*' as one of the indicators in the evaluation of the scope, manner and regulations that enhance business activity.

1.2.3 Land administration

The relationship between man and land is of fundamental importance in every society. Economically, land, together with its associated buildings and constructions is one of the most important financial assets. Good land administration provides security to investors and permits real properties to be traded. It also allows government to collect tax. A study from EIU (Economist Intelligence Unit) in 1997 concluded that "*while the importance of real estate in foreign direct investment (FDI) is difficult to gauge ... however, a rough estimate on the basis of existing data would implies that the real estate component of FDI could be anywhere between 5 – 20% of the total*". De Soto [*13*] further argues, "*without representation, ... assets are dead capital*". Thus, access to land and security for credit is vital to sustainable development and good land management practice.

As a whole, land administration is the process of determining, recording and disseminating information about ownership, value and use of land when implementing land management policies [*3*]. It provides a mechanism that supports the management of real properties, both from an environment and an economic perspective. It includes regulating land and property development, use and conservation of land, taxation and resolving conflicts resulting from ownerships and use of land. The basic building block of any land administration is none other than the cadastral parcel, which in conjunction with land rights registration and management, land use allocation and management as well as land valuation and taxation constitute the four basic components of land administration [*46*].

Fig. 2: Four basic components of land administration [*ibid*].



1.2.4 Cadastre as public land register

Cadastre is a parcel based land information system containing a record of interests in land, which include the rights, restrictions and responsibilities. It comprises a geometric description of land parcels; linked to an administrative register that describes the nature of the interests, ownership (control) of the said interests, its land value and its improvements [*19*].

1.3 Motivation of Research

In areas with intensive use of land, the demand of land has extended into space under and above the surface. Traditional cadastre defines the legal boundaries of parcels (used for the registration of its legal status) in 2D space. This mode of representation is unable to reflect the vertical component of the legal status of today's complex real property objects, as most of these 3D relationships are

currently being registered administratively. These vertical dimensions are stored as attributes of the defined 2D surface parcels.

As there are more and more upwards and downwards construction situations, the vertical dimension becomes an important factor in registering the legal status of these real property objects. In order to define and manage the juridical situation satisfactory, 3D geo-information is therefore indispensable.

There has been a keen interest in the establishment and improvement of land information systems over the past decade. Cadastre, being the central component of a land information system, supports the provision of secure property rights in land. It is no wonder that the focus is shifting from "*whether cadastral system is necessary*" to "*which is the most appropriate cadastral system*" for a particular country.

The traditional parcel-based cadastral system, dealing only with 2D surface properties, is found to be inadequate for registering today's complex property situations. This research aims to explore the feasibility of introducing 3D cadastre into Malaysia Cadastre, as a 3D representation will permit better definition of cadastral spatial subdivision.

1.4 Problem, Objective and Scope

In spite of the different social, political and economical and administrative background of each society, it is possible to develop an affordable cadastral registration system best suited for its local needs and requirements. Malaysia, as a developing nation has much to learn from modern cadastres, to derive a land registration system that can best fulfil its needs effectively, efficiently and affordably.

1.4.1 Problem definition

Cadastre is an "*essential part of the legal, regulatory and institutional infrastructure which supports secure property rights in land, arguably the most important form of property rights in a developing country*" [*59*].

For Malaysia, cadastral mapping has been providing vital land information ever since the colonial days. The cadastral maps from the national survey and mapping agency - JUPEM, providing digital information on land parcels such as parcel numbers, its geometry and dimensions. Land registration, on the other hand, is handled by each respective state's Land Office. Currently the legal description of land differentiates lot (surface parcel), strata parcel (multi-storey apartment parcel) and stratum parcel (underground parcel). Nevertheless, all the information about land is basically two-dimensional in nature.

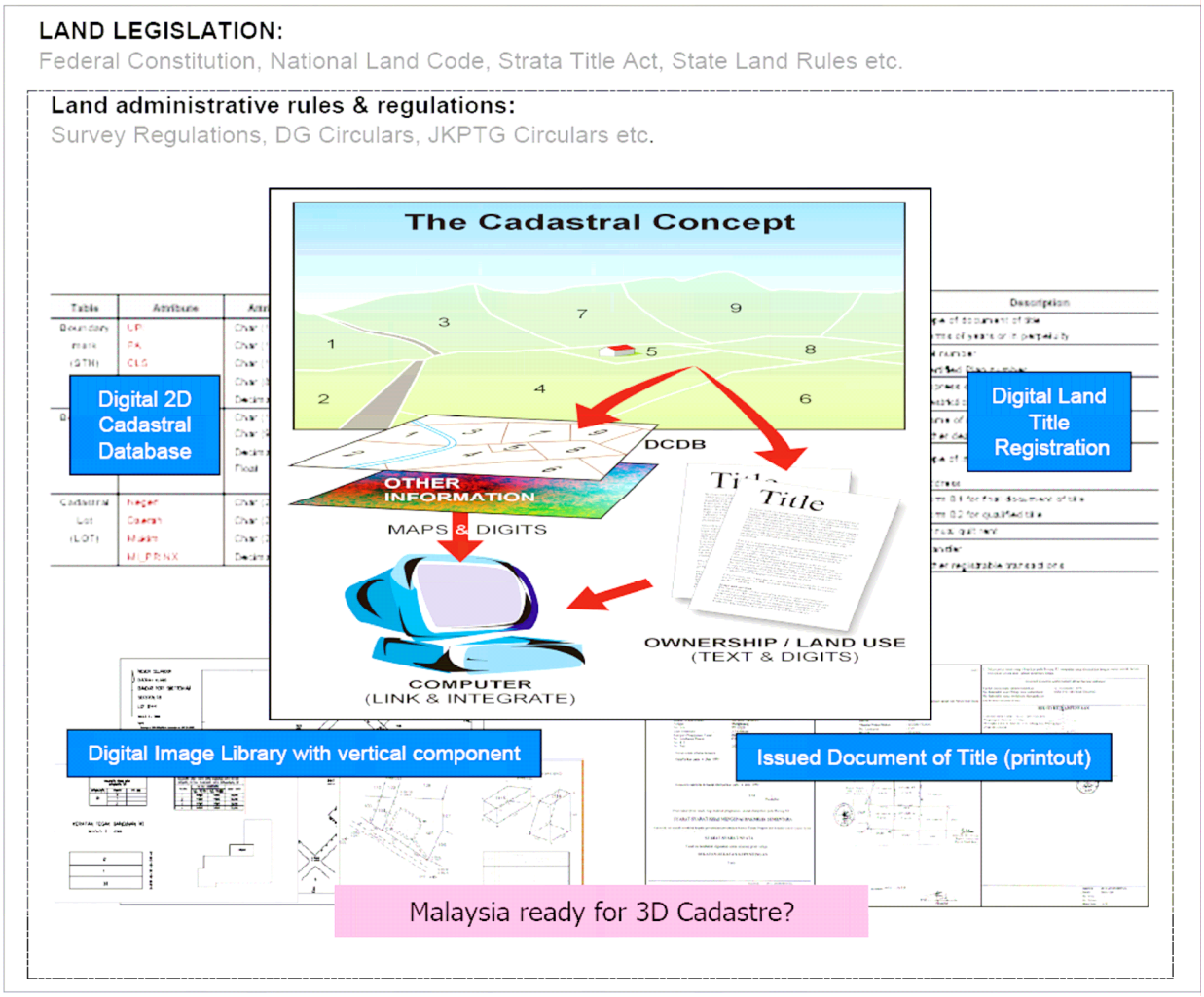
The cadastral map provides information for identification of land parcels for survey and land registration. The authenticated cadastral map (CP or certified plan) depicts technical data (e.g. bearings, distances and the 2D coordinates of two extreme boundary marks), and also other relevant information when dealing with strata and stratum alienations. The strata plan (for buildings with two or more storeys) contains not only the parcel information where the multi-storey building

resides, but also additional information on the storey height of the building and the strata parcels. Likewise, the stratum plan provides the additional depth information of the underground volumetric parcels. Currently CP has been digitised into the digital cadastral survey database (DCDB).

The process of recording rights in land is via registration of title of land. Land matter in Malaysia is basically a state object, handled by the respective state Registry Office and District Land Offices. All dealings with land can only be registered at the Registry or District Land Office, depending on where the document of title was formerly registered. However, since the Computerised Land Registration System (SPTB) was being introduced, the register of land that furnishes information pertaining to the land, ownership and rights can be digitally accessible throughout the state.

Cadastre, being a parcel based land information system, consists of a spatial and a non-spatial part. Under current Malaysia practice, the issue of contention is whether the existing 2D-cadastral framework, the cadastral survey's DCDB and title registration's SPTB is able to reflect the real world spatial information about the rights of modern constructions, especially with respect to the all-important vertical component.

Fig. 3: Framework of current Malaysia Cadastre.



1.4.2 Objective of research

JUPEM has in fact provided the relevant procedures for the conduct of strata and stratum surveys, yet the DCDB has no provision to depict parcels in the 3rd dimension. Thus current approach is basically 2D+1D, which puts emphasis on the planimetric dimensions, yet provides additional information for the strata and stratum parcels.

This research aims to study the feasibility of registering the legal status of the various stratified property situations, by expanding into the 3rd dimension, leading to a proposed 3D cadastre in Malaysia's perspective.

1.4.3 Scope

The Bogor Declaration on Cadastral Reform [*53*] pronounced that modern cadastral infrastructures "*facilitate efficient land and property markets, protect the land rights of all, and support long term sustainable development and land management*".

In view of the evolution of cadastral systems, this research considers the changing man-land relationship and the consequent cadastral respond to that relationship, focussing on the following scope:

a. Identify stratified properties that require the inclusion of the 3rd dimension into the current surface parcel registration
b. Study the current cadastral registration in order to incorporate current and future stratified property situations, with reference to the juridical, organisational and technical frameworks. However, emphasis is on the first two aspects
c. Evaluate the feasibility of introducing a 3D cadastre under current frameworks
d. Investigate and recommend changes if necessary, in order to provide better definition for cadastral spatial subdivision that include the official ascertainment of boundaries as well as ascertaining the rights in land, or adjudication in short

1.5 Research Approach

The focus of this research is to study the 3D cadastral implementation in developed countries, taking into account of the role of modern cadastre as part of a larger land information, evaluate trends and to show the means by which the existing cadastre can fulfil the needs of Malaysia society, effectively, efficiently and economically. Given such emphasis, a case study approach is more appropriate, by evaluating for a possible solution basing from a broad range of similar phenomena.

The choice of an appropriate cadastral registration system depends upon local conditions. This may depend on the local legislation, the available human and technical resources, climate, topography and vegetation; upon the available time and finance, or the intended secondary uses of these survey information.

1.6 Thesis Outline

This thesis consists of 5 parts, the *introductory*, the *background analysis*, the *Malaysian Cadastre* at current stage, the case study on *current practice of 3D registration*, and the evaluation and proposal part of *towards 3D registration in Malaysia* and the *conclusion*.

Table 1: Overview of thesis chapters.

Part	Chapter
I Introductory	1 Introduction
II Background Information	2 Background Analysis
III Current cadastre	3 Current Malaysian Cadastre
IV Case study	4 Current Practice of 3D Registration
V Evaluation and proposal	5 Towards 3D Registration in Malaysia 6 Conclusion

The background part includes chapter 2, which introduces the general concepts of cadastre and the needs for 3D registration. The current cadastre part has chapter 3, which reviews the current Malaysian cadastre, with emphasis in both the juridical and organisational frameworks. The case study part consists of chapter 4, which looks into the examples of 3D registration in countries such as the Netherlands, Israel, Norway and Australia. Lastly the evaluation and proposal part consists of chapter 5 and 6, to review the findings of the case study, then to evaluate the possibility of introducing a 3D registration in Malaysia's perspective.

2. BACKGROUND ANALYSIS

The aim of this chapter is to provide an introduction into the nature of land, the need for land information and to review the evolving nature of modern cadastre in relation to 3D representation.

It begins by an introduction on the concept of land within the society and the importance of having accurate knowledge and the proper recording of such knowledge, in order to manage rational land use and conservation. Intensive use of land and technology advance has forced modern constructions to extend skywards, and downwards to maximise usage of space. This is why there has been growing awareness on the need in finding a cadastral solution to register these rights in 3D space effectively. The possible solutions range from full 3D cadastre, 2D/3D hybrid to 2D cadastre with 3D tags, and the concept of "*best practices*" shall be the basis to evaluate the current Malaysian Cadastre (Chapter Three) and to study the strengths and weaknesses of the case studies (Chapter Four).

2.1 Land and Society

The relationship between man and land is of fundamental importance in every society. Land rights define what may be done to the land. Rights can be described as a bundle of sticks, one for each thing that can be done with the land, subject to certain restrictions or responsibilities.

2.1.1 Land

Land is the foundation of all forms of human activities. Land provides shelter, and by applying labour, we obtain food and raw materials necessary for our existence. Sir Bernard Binns [7] mentioned that:

> *The land is man's most valuable resource. It is indeed much more than this: it is the means of life without which he could ever have existed and on which his continued existence and progress depend.*

UNECE's ECE/HBP/135 (2004) further defined land as:

> *The surface of the earth, the materials beneath, the air above and all things fixed to the soil.*

It does not simply means something physical (soil, building, tree etc), but also about the rights that people may have in land. These rights are of two types: material and spatial. The dual nature of land can be portrayed as the physical material of the earth, and alternatively as an abstract volume of air space.

The control over land (ownership) regulates the man-land relationships in the form of property rights. Access to land and security for credit is crucial component of sustainable development and good land management practice. Sir Bernard Binns [7] further argued that:

> *Accurate knowledge of natural resources and accurate description and record of such knowledge are the first essentials to their rational use and conservation.*

All decision-makings require information. Information helps to identify and analyse problems by reducing the uncertainty. Every nation needs to ensure that an effective and efficient land administration mechanism is in place, as land information is the prime requisite for making decisions related to land investment, development and management.

2.1.2 Land tenure

There are three categories of institutional structure in the society and economy that governs the role of property rights in general and land rights in particular. *Constitutional orders* are the rules for making rules, the fundamental rules in how society is organized. *Institutional arrangements* are created within the rules specified by the constitutional orders. They include laws, regulations, associations, contracts and focus of this section, property rights in land. *Normative behaviour codes* refer to the cultural values that legitimize the above arrangements and constrain behaviour.

Law in general provides a complex set of rules that have evolved within each society in ensuring an orderly running and peaceful behaviour of its members. The first being the statutory law, whereby all rules and regulations are written down and codified. Customary law, on the other hand, has no written record but all members of the society know the code.

The law of property deals with the relations between people (in personam) and persons to things (in rem). There are various types of interest in property, differentiating between the physical object and the abstract rights associated with its use. Land as real or immovable property is normally taken to include the surface soil (also the minerals, water below the surface and air above, unless specifically excluded) and all things attached to it (such as buildings or other permanent fixtures). Rights describe what may be done with property, thus provide the institutional foundation to address:

a. Who can create new property or prevent its creation
b. Who owns the property, either in whole or in part of
c. Who can qualify as vendor (seller) or purchaser (buyer)
d. How (in what ways) it may be used
e. Who may use it, or stop it from being used
f. Who is entitled to the benefit of its use
g. Who may alter or add value to the property
h. What are the legal liabilities for the quality of the property
i. How may the property rights be protected, for the owners, third parties or general public

Land tenure implies a relationship between people and land, expressed through property rights. It describes how persons can exercise and enjoy the rights in land, governed by a broad set of rules either within the statutory law (as property laws) or in unwritten customary law (as determined by custom).

UNECE's ECE/HBP/135 (2004) defines land tenure as:

> *The mode of holding rights in land.*

It covers not only the rights of disposal (to grant land, sell, mortgage etc) but also the rights of possession (to occupy and to use the land), subject to certain restrictions or obligations. Interests in land means every interest in land, including but not limited to, fee simple ownership, easements, covenants that run with the land, leaseholds and other estates in land.

Peter Dale and John McLaughlin [*11*] further remarked that land tenure:

> *Involves not only vendors and purchasers, owners and occupiers, but also third party interests, especially those concerned with the use of the land by future generations.*

Sustainability means balancing the economic and ecological perspectives of development, without bankrupting the resources of future generations. Thus an effective property rights regimes should [*36*]:

> *Specify both individual and collective rights and responsibilities; address the relationships between ecosystems and institutional structures that affect them; limit transaction costs; create monitoring and enforcement processes at appropriate scales.*

Property rights are an important class of institutional arrangement. According to Armen Alchian [*1*]:

> *The fundamental purpose of property rights, and their fundamental accomplishment, is that they eliminate destructive competition for control of economic resources. Well-defined and well-protected property rights replace competition by violence with competition by peaceful means.*

There are three types of property: common, private and state. Common property is vested in a community and is specified by the right of all members of the community to access. A member has a right not to be excluded from the use or enjoyment of the object owned. Examples of common property are roads, public parks and recreation facilities. Private property is specified by individual to exclude others from the use or enjoyment of the object owned. State property, however, is vested in public agency, which although was created to serve the public, but maintains strict control and allows only limited access.

Property rights matter for their effects on economic inequality and economic performance, and they unfold at the intersection of law, the state, politics, and the economy. The five characteristics of property rights are:

a. Objects of property – what can be owned
b. Subjects of property – who can own
c. Uses of property – what can be done with
d. Enforcement of rights – how property rules are maintained
e. Transfer of property – how property changes hands between different owners

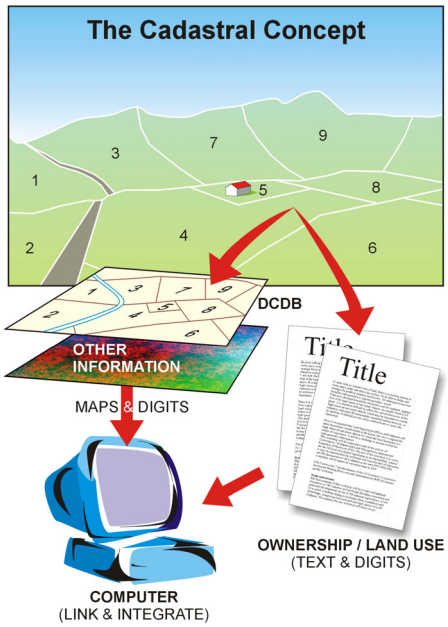
2.1.3 Cadastre

Information is the basic resource in all decision making. A land information system supports land management by providing information about the land, the resources upon it and the improvements made to it. The basic building block in any land administration system is the cadastre parcel. The definition of cadastre by FIG [*19*] is:

> *A cadastre is the core or basis of a land administration system and is defined as a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of interests, the ownership or control of those interests, and often the values of the parcel and its improvements.*

As a parcel based land information system, the cadastral data are organized around the cadastral parcel. It consists of two parts – the registers and the maps. The concept can be shown diagrammatically as below:

Fig. 4: FIG cadastral concept [*ibid*].



The principal function of a cadastre is the provision of data concerning land ownership, value and use. It is the primary means of providing information about land, including:

a. Information identifying people with interests in parcels of land
b. Information about those interests (nature and durations of rights, restrictions and / or responsibilities)
c. Information about parcels (locations, size, improvements, value)

Parcel based land information systems can be classified according to the information they contain or its function. There are three commonly recognized types – legal (juridical) cadastre, fiscal cadastre and multipurpose cadastre. A juridical cadastre provides the legally recognized record for land tenure, thus supports the land markets. Fiscal cadastre supports land taxation, developed mainly for property valuation. Multipurpose cadastre actually encompasses both the basic juridical and fiscal

components within the cadastre, in addition to other parcel related registers or information. The multipurpose cadastre closely resembles the universal concept of land information system, independent of neither a particular level of technology, land tenure system nor the administrative structure (centralised or decentralised, at local, regional or national level).

2.2 Today's Cadastre

Cadastre, being an important tool in administering the man-land relationship is constantly evolving itself in responds to the dynamic nature of the man-land relationship within that particular society.

2.2.1 The evolution of modern cadastres

Cadastral systems have been in existence since the Egyptian time around 3000 BC. The ancient Romans and China both established such institution mainly for taxation purposes. Over times, the introduction of systematic inventories on land also caters for land use control. And after private land ownership became more common, they were providing security and reliability and became a basis for land markets.

Cadastre is dynamic and continues to modify its role in society, in as much due to the evolution of necessities as due to the generated impacts of scientific and technological development within the field and its area of interest. The development of communication (electronic mail, internet) has made it possible to share cadastral experiences with larger communities of national and international dimensions while generating new opportunities, especially in those countries whose economies limit the more expensive forms of communication.

These new perspectives have made it possible for different players involved with land information at local, national, regional and international levels to combine their forces, direct their objectives, and steer towards collaborative projects with the aim of maximising the social, economic and environmental benefits of land information.

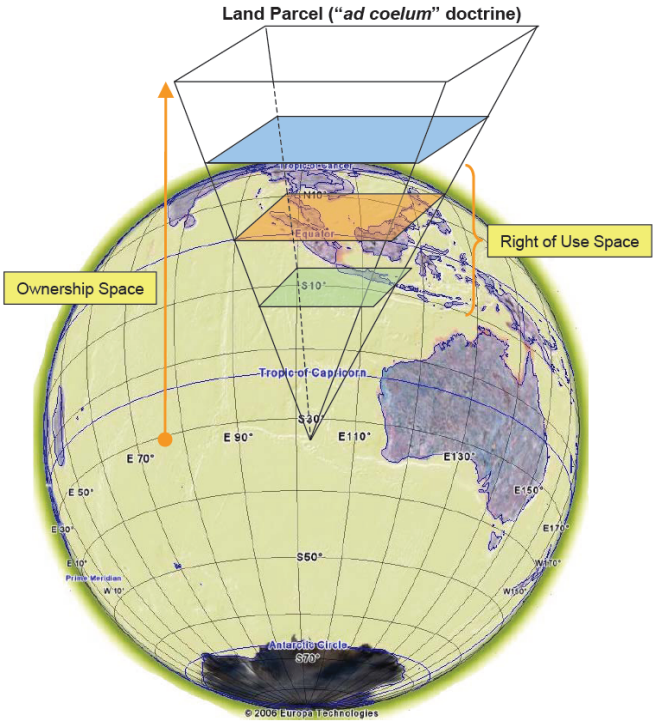
2.2.2 The changing relationship between man and land

Cadastre, as an essential tool in administering the relationship between man and land, is continually evolving in response to the changing man-land relationship. The key to a better and efficient land administration and management relies on reviewing the existing cadastral systems, with reference to the changing needs of societies, while taking into account the possibilities of modern technology to make cadastral work much more effective and efficient.

2.3 3D Cadastre

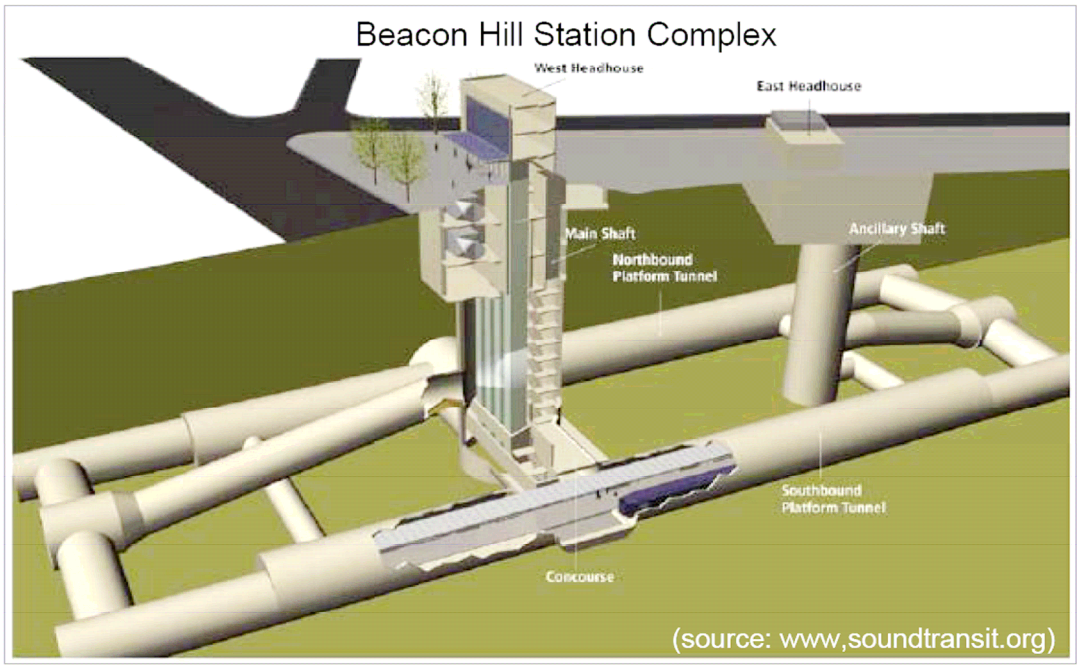
Traditional legal doctrine represents land ownership in the form of a cone down to the centre of earth, as expressed in the Latin phrase "*Cujus est solum, eius est usque ad coelum et usque ad inferos*" (the owner of the land owns everything up to the sky and down to the centre of the earth [*58*]). Another Latin maxim further stipulated that "*Quicquid plantatur solo, solo cedit"* (whatever is attached to the land becomes part of the land [*ibid*]). Nevertheless, this principal of land ownership has been greatly tempered by case law which limits the rights of owner to such an extent (either vertically upwards or downwards) as is necessary for the ordinary use and enjoyment of the land, beyond which he has no greater rights than any other member of the public.

Fig. 5: Extent of land ownership as a cone down to the centre of earth, the infinite ownership space and the finite right of use space (adapted from [*6*]).



In areas with an intensive use of land, there is a growing demand to utilize space above and under the surface, resulting in multi-level use of land. Multifunctional land use combines different functions within one area often resulting in overlapping and even interlocking constructions (so called stratified properties). With today registration of real estate property confined to 2D topological and geometrically described parcels, most of the 3D relationships have to be registered administratively.

Fig. 6: Graphic representation of interlocking stratified properties
(source: www.soundtransit.org)



2.3.1 Stratified property

Today's property situations often occur whereby the third dimension play a significant role in determining the legal status of such property, especially in areas with multilayer use of space. Examples of such property unit can be found in the following situations:

a. Above surface constructions
   - Apartments
   - Constructions on top of each other
   - Overhead infrastructure and utilities
   - (Use of) air space (constructions over water or (may be) self supporting structure floating in the air)

b. Below surface constructions
   - Underground constructions
   - Underground infrastructure and utilities
   - Region of polluted area
   - Geological activities

Fig. 7: Definition of space (adapted from [*20*])

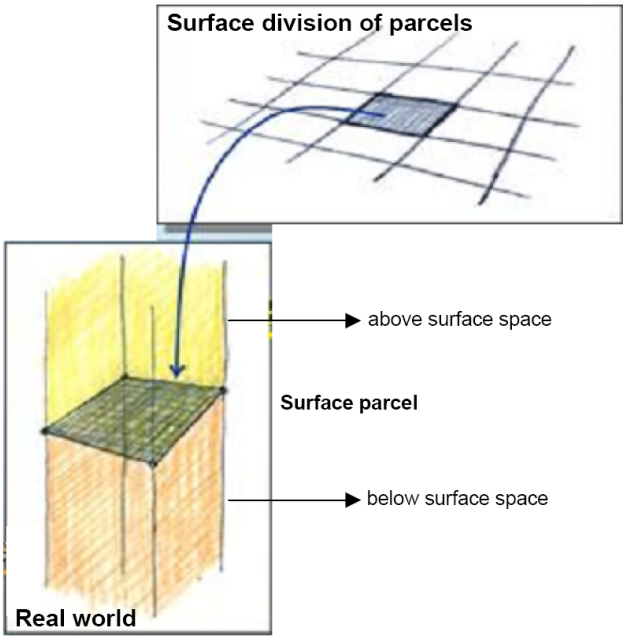
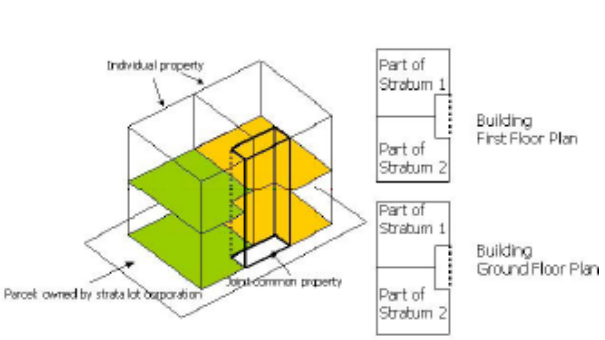
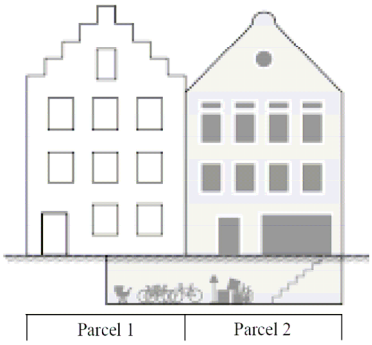


Fig. 8: Examples of above surface constructions [*48*].

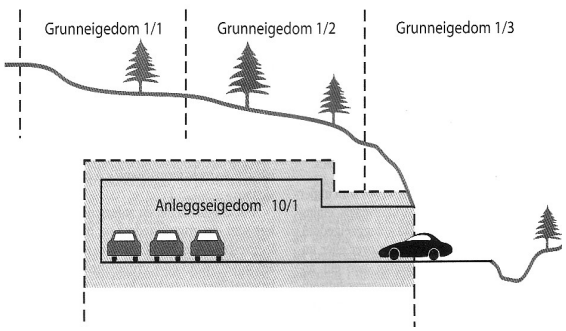


(multi-storey apartments).



(interlocking apartments).

Fig. 9: Examples of below surface constructions.



(underground parking [*54*])

(buried utility,
source: www.centerforwater.net).

2.3.2 The need for 3D cadastre

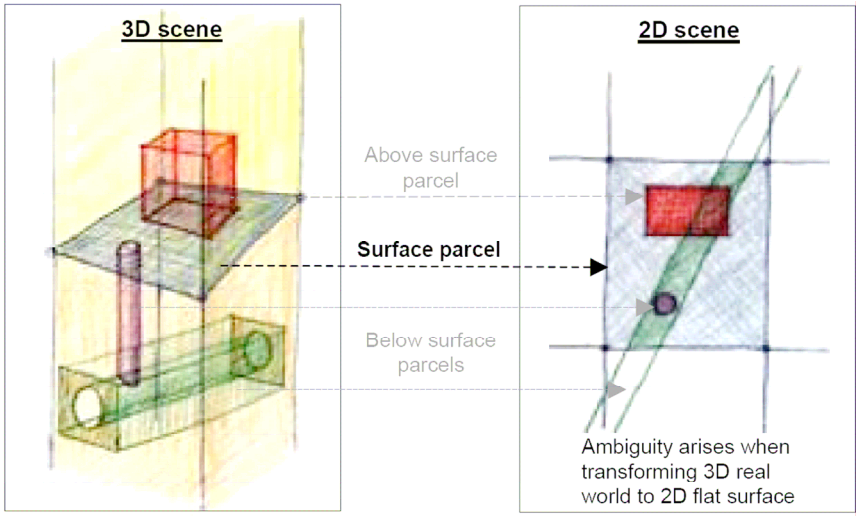
The space we live in is a three-dimensional space, commonly known as length, width and breadth. Modern Cartesian coordinate system specifies the position of a point or object on a surface using two intersecting axes as measuring guide, hence it is called two-dimensional (in x, y). When another z-axis is added, it provides a sense of third dimension (thus added up as 3D, in x, y, z) of space measurement [*57*].

Man has always been extending his domain vertically on both side of the surface of earth. His shelter is constructed in the above surface space (lying immediate above the surface area of land), while his crops are grown in the below surface space (lying below the surface area of land). This is why land tenure has had to reckon with this vertical dimension as the concept of land is always in three-dimensional space.

In fact the rights to a parcel is always in 3D as it would be impossible to use the property if confined only to the defined 2D flat surface. Nevertheless, cadastre is traditionally based on 2D flat surface. This traditional registration is proved to be sufficient (complex situations registered based on 2D legal object) from the juridical perspective, but it has shown limitations in providing insight in the (the 2D and 3D) location of the stratified constructions [*25*].

It is often difficult to translate the information in total during the transformation from one system to another. Similarly, when the legal status of land is transformed from the real world to 2D plane (either by descriptive texts or drawing), ambiguities often arise. A picture is said to be worth a thousand words, yet a 2D drawing could not completely portray reality in 3D. *Fig. 7* above shows the division of above surface and below surface space along the surface parcel, while *Fig. 10* illustrated the limitations when depicting 3D information in 2D surface.

Fig. 10: Complications when projecting 3D scene onto 2D scene [*20*].



Moreover, there are growing interests for 3D cadastral registration, mainly due to the considerable rise in property value; growing number of underground constructions (tunnels, parking lots, shopping malls etc) and utility cables and pipelines (water, gas, electricity, telecommunication, sewerage). Progresses in 3D GIS, 3D Planning etc. have also made the process technologically viable.

The legal status of factual situations with a 3D component cannot be represented in the most efficient manner under the current 2D representation. The introduction of the third dimension is deemed necessary, so as to be able to provide efficient means to register and to provide the legal status of these objects as in the real world.

Cadastre shall be able to provide sufficient and clear insight about the property, about its boundaries in all dimensions, even for complex stratified property situations. Stoter [*48*] categorised the basic need of a 3D cadastre as:

- Complete registration of 3D rights (explicitly register one's rights to volumes, as 3D space to which these rights apply)
- Good accessibility to the legal status of stratified property, including its 3D spatial information

She further concluded that 3D cadastre should provide the following functionalities, some of which require a working underlying national Geo-information Infrastructure (GII):

- Register 3D information on rights, and make this information available
- Provide the required link to external databases (those with objects of interests to cadastre, such as infrastructure, sensitive ecology areas, forest reserve, archaeological monuments etc), and to incorporate the location and other related information of these objects into cadastral registration
- Use the spatial and other related information of the above objects to further edit and update the cadastral registration

Accordingly the advantages of having a 3D cadastre are listed as [*ibid*]:

- 3D registration provides information on the 3D extents of rights (inclusive also restrictions and responsibilities, see §2.4.1)
- Information on 3D situations is in digital format, instead of descriptive texts or analogue drawings (hard copy or (scanned) image file)
- Accessibility of the registration in 3D situations is optimal (data storage, validation and queries) as digital 3D representation is provided and readily accessible. Digital information allows efficient data administration, maintenance and quality control, also data transfer within the national GI
- Spatial analysis is possible, as 3D property units can be queried, in the same manner as (surface) parcel can be queried in current 2D registration
- The legal status of 3D situations and other spatial information can be maintained systematically, hereby promote a uniform and readily accessible recording of 3D property units

<u>And also in other applications;</u>

- The spatial recording of 3D infrastructure constructions provides additional reference for registration updating and also support other cadastral tasks, reducing discrepancies (between cadastral registration, associated analogue drawing or descriptive texts in deeds)
- Linking infrastructure constructions with cadastral registration provides the foundation for utility mapping, giving rise to the possibility of setting up a central utility marking clearinghouse, and efficient means for the planning, construction, administration and maintenance of such utilities

- Land and property related data are also the most important source of information, providing an accurate and up to date spatial basemap that supports the planning and management of limited earth resources, such as town and country planning, land use planning, property management, building administration, traffic control, ambulance service, landscape modelling and 3D city modelling, location based services (LBS), geological applications and disaster prevention and management etc.

2.4 Feasible Solutions

In view of the ever-increasing demand for 3D representation, Stoter [*48*] proposed the following options:

a. Full 3D Cadastre
b. 2D/3D Hybrid
c. 2D Cadastre with 3D Tags

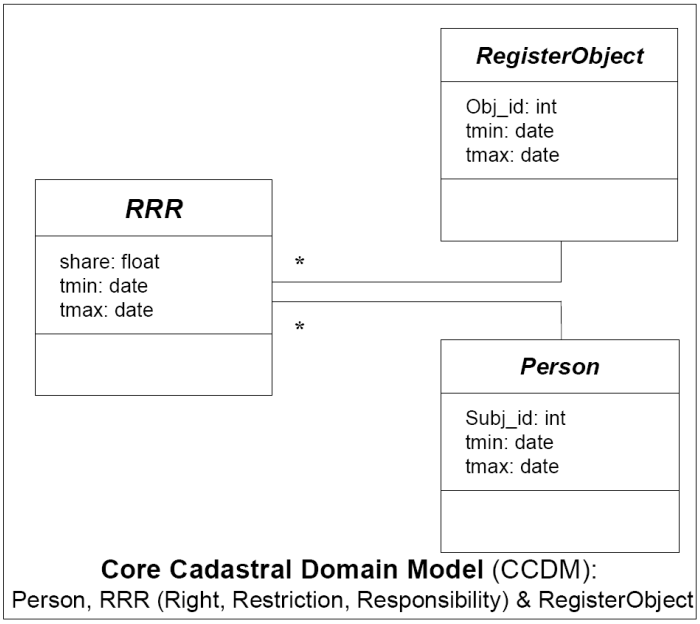
2.4.1 Core cadastral domain model (CCDM)

The use of standardized CCDM serves to provide an extensible basis for the efficient and effective cadastral system development based on a model driven architecture. This avoids the need to repeat the process of reinventing and re-implementing the same functionalities. CCDM also provides the common communication platform within the various parties involved using shared ontology implied by the model.

Several CCDM versions have been developed, adjusted each time based on the discussions at the various workshops, and the consultations with several countries all over the world. From the well-known concept of Parcel, Person and Right, CCDM has been evolving ever since the first version (Noordwijk 02) was presented in September 2002. The current version is called 'Moscow 05', it has three core classes: Person (also called Subject), RegisterObject (e.g. parcel) and RRR (right, restriction, responsibility). The various UML class diagrams by Stoter [*ibid*], representing the various cadastral conceptual models has all been adapted accordingly.

The UML (Unified Modeling Language) class diagram below illustrates the relationships between the real property objects (RegisterObject) and Person (natural person or non-natural person) via RRR (right, restrictions, responsibility) [*56*]. This data model is the foundation of most of the land administration.

Fig. 11: CCDM: Person, RegisterObject and RRR [*ibid*].



A person can be associated to any number of RRRs (multiplicity '*'), while a RRR can involve only one person (multiplicity omitted, indicates '1'). Similarly, a RegisterObject can be associated to any number of RRRs, but a RRR can involve only one RegisterObject. There is no direct relationship between Person and RegisterObject, but only via RRR.

2.4.2 Full 3D cadastre

The real world is being partitioned into 3D volume parcels, representing the 3D proprietary rights. In order to support this hypothetically ideal and final solution, the legal basis, real property transaction protocol and cadastral registration should be in place for the establishment and conveyance of 3D rights. In this approach, rights are no longer established on parcels, but on well-defined volume parcels.

The same UML data model explained in §2.4.1 (*Fig. 11*) is still applicable. It differs only in the way the object is being defined. The cadastral objects are defined in 3D (as 3D parcel), with rights related to the 3D parcels. There shall be no relationship between surface parcels and the 3D physical objects, as both are not represented. There are two variants within the full 3D cadastre. First being the combination of infinite parcel column (traditional extent of ownership from 'hell' to 'heaven') and volume parcel (bounded parcel). In the second variant, all should be in the form of well defined and bounded volume parcels.

The implementation of this proposed solution is rather impractical at this stage. The concept of 3D volume parcel poses a serious challenge on the traditional doctrine of land ownership as cone down to the centre of earth. To define the extent of ownership in the vertical plane required extensive and complicated overall 3D land title settlement prior to cadastral survey. On the legal aspect, a change in the relevant land law is required, but it is itself a lengthy process. Furthermore, current DBMSs support few geometry or topology functions in 3D. This is definitely a mammoth and costly task.

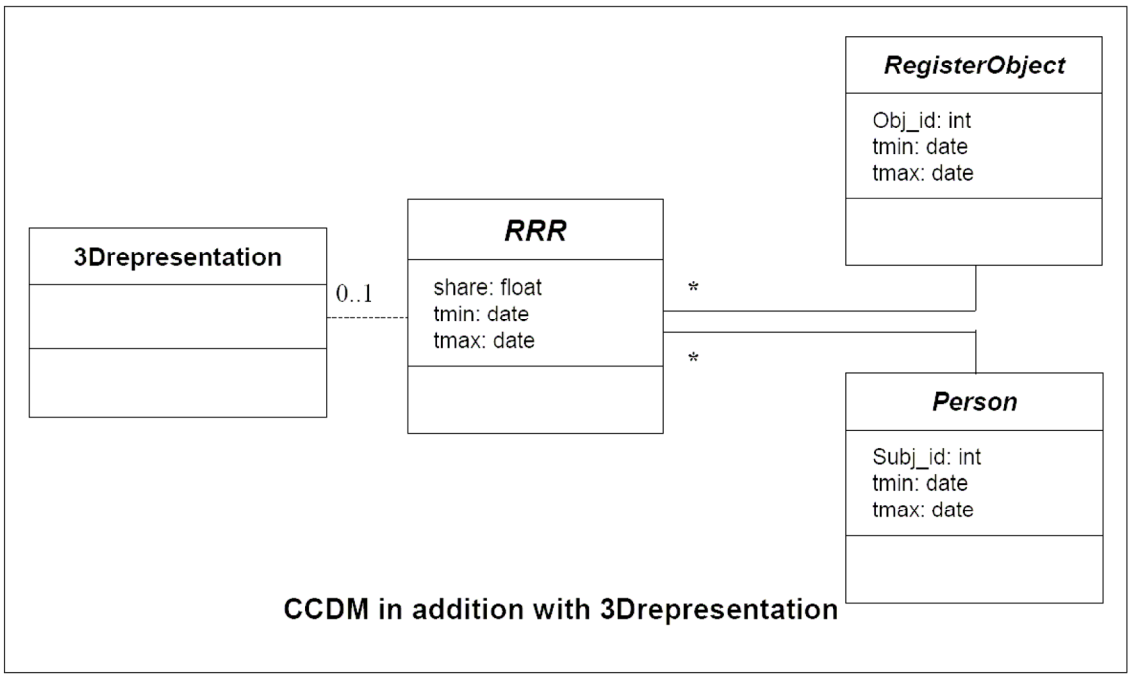
2.4.3 2D/3D hybrid

The 2D cadastre is being maintained in addition to register the factual situation in 3D space by registering 3D objects within the 2D cadastral registration. There are two options to register 2D parcels and 3D situation within one system. The first being the registration of 3D right-object defined by the surface parcel bounded by the upper and lower limits. Second being registration of 3D physical-object, i.e. by registering the 3D physical object itself (defined by its geometry and attributes).

The same UML class diagram as in §2.4.1 (*Fig. 11*) is still applicable for this alternative, but there is an additional class of 3Drepresentation. This 3Drepresentation can be either the volume to which a person is entitled (registration of 3D legal space) or a physical object itself (registration of 3D physical object).

3D legal space is different from 3D physical object as it is an abstract (non-visible) object. Registering 3D physical objects meets the requirement to register itself as 'Object', and the exact spatial location of the object is then available in the cadastral registration (which will also be shown on cadastral map).

Fig. 12: General UML class diagram for 2D/3D hybrid cadastre (adapted from [*56* and *48*]).

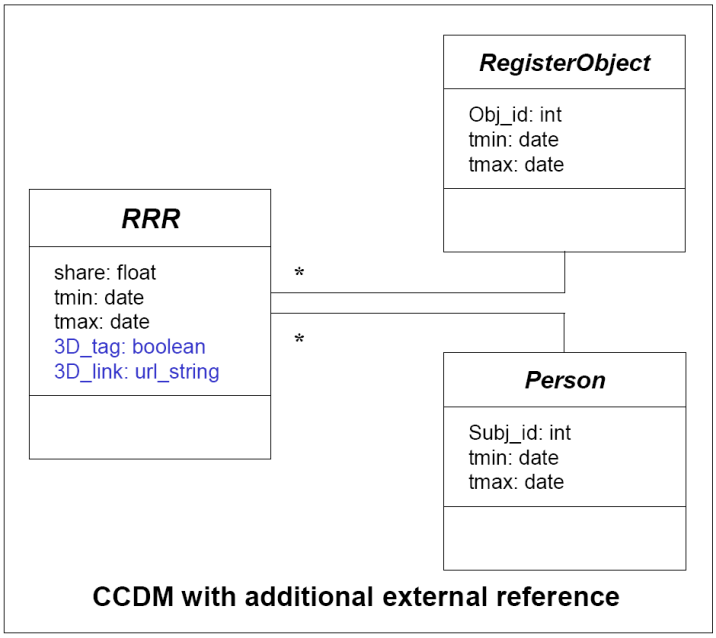


2.4.4 2D cadastre with 3D tags

The current 2D cadastre is being preserved, but with additional references linking to 3D analogue or digital CAD drawings. The external reference linking to the 3D situations can be in the form of simple tag (3D_tag: boolean, whereby user needs to refer to the registration deed for detailed information) or a reference link (3D_link: url_string), to the digital drawing file maintained in the cadastral registration.

This approach is similar to current practice. The tagged drawings can be accessible via 2D parcel, only for the purpose of viewing. There is no linkage to current administrative databases, thus no query is possible.

Fig. 13: General UML class diagram for 3D tag cadastre (adapted from [*56* and *48*]).



2.5 Benchmarking Land Administration Systems

Comparison is an important source for learning, identifying and monitoring strengths and weakness, as the saying - "*what you cannot measure, you cannot improve it*". The benefits in benchmarking land administration systems can be summarised as [*46*]:

- Demonstrate strengths and weaknesses of land administration systems
- Justify the need to improve its land administration system and identify areas and priorities for reform
- Justify an investment to improve
- Monitor improvement
- Provide a basis for comparison over time
- Enable cross-country comparison in land administrative performance

However, a common comparison framework is difficult to derive as land administration systems have strong social, economic and environmental links and implications, all depending on the society's perception of land. Nevertheless there are seven "*best practices*" where a land administration system can be evaluated, there are [*60*]:

- Land policies principles – how land administration system is supporting good governance and sustainable development
- Land tenure principles – determine which bundle of rights are to be included into registry system
- Land administration and cadastral principles – understand the concept and components of cadastral and how these can be implemented
- Institutional principles - evaluate the structure and organisation aspects, such as which are the land related government agencies and how they are organised (centralised / decentralised)
- Spatial data infrastructure (SDI) principles – include issues like definition of data standards, access to data, privacy issues and pricing
- Technical principles – determine which sort of surveying and mapping techniques and options for recording land tenure relationships that best suit the country needs and requirements
- Human resource development – establishing appropriate land administration system and ensuring a continuous supply of trained personnel to operate the system

It is beyond the scope of this research to evaluate the appropriate evaluation framework to compare and evaluate the most feasible 3D cadastre for Malaysia. The above "*best practices*" shall only provide the guidelines to research on the current practice of Malaysia Cadastre (Chapter 3), and also while formulating possible options (Chapter 5) by investigating the strengths and weaknesses of the selected 3D cadastral case studies (Chapter 4).

3. CURRENT MALAYSIAN CADASTRE

Every country is unique, differs in its social, political, economic, legal and physical environments. Cadastral registration system should have means to improve and to cope with changing social and economic needs, by reforming existing system and making legislative changes to support a complete and secure cadastre. The search is toward a suitable system that responds best to the needs of land resource management, by recording the land ownership, its use and value and land use in a way that is cost effective, yet meets the needs of government and the local community.

This chapter provides some background information on Malaysia, then continues to introduce its land administration system, the legal framework and how the current cadastral registration is being undertaken by the national mapping agency and the respective state authority. Next the existing cadastral model, the data structure and content of the two cadastral databases are being elaborated in detail, follow by exploring how present 3D situations are being represented. The discussion then focuses on issues related to land administration as well as the strengths and weaknesses of current registration system, in particularly those related to 3D registration.

3.1 The Country

Malaysia is formed in 1963 as a federation of 13 states in Southeast Asia. The country consists of two geographical regions separated by the 1,024 kilometres (640 miles) wide South China Sea. Eleven states (Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang, Selangor and Terengganu) and two federal territories (Kuala Lumpur, the capital and Putrajaya, the new administrative centre) make up of West Malaysia (Malay Peninsula, also known as Peninsular Malaysia), bordering Thailand at the north and is connected by the Strait of Johore on the south with Singapore. East Malaysia consists of Sabah and Sarawak and federal territory of Labuan, located on the northern part of the island of Borneo, bordering Indonesia and Brunei.

Fig. 14: Malaysia consists of West Malaysia and East Malaysia.

The system of government is closely modelled from Westminster, a legacy of British colonial rule. The official head of state is the Paramount Ruler (Yang di Pertuan Agung). Under the 1957

constitution, a monarch is elected for a five years term by and from the hereditary rulers of the nine peninsular states (Johor, Kedah, Kelantan, Negeri Sembilan, Pahang, Perak, Perils, Selangor and Terengganu). The Paramount Ruler's powers are similar to those of the British Monarch, but generally the monarch acts on the advice of the prime minister and cabinet, who wield effective power.

Nevertheless, more power is vested in the executive branch of government than in the legislative. Executive power is vested in the cabinet led by the prime minister. Legislative power, on the other hand, is divided between federal and state legislatures. Chief ministers, selected from each state assembly, lead the 13 state governments. Each state has its own state constitution, head of state, and elected state assembly, led by a chief minister and state cabinet, and legislate on matters outside the federal parliament sphere.

3.1.1 Key facts

Location	Southeastern Asia, peninsula bordering Thailand in the north and Singapore in the south, Sabah and Sarawak at northern of the island of Borneo bordering Indonesia, Brunei and the South China Sea.
Geographic location	Close to the equator, between Latitudes 1° and 7° North and Longitudes 100° and 119° East.
Area	*Land*: 328,550 sq km *Water*: 1,200 sq km ***Total***: 329,750 sq km.
Climate	Tropical.
Population	26.64 million ([*14*], updated as per May 31, 2006).
Ethnic groups	Malay 50.4%, Chinese 23.7%, Indigenous 11%, Indian 7.1, others 7.8% (2004 estimate).
Religions	Muslim, Buddhist, Taoist, Hindu, Christian, Sikh.
Languages	Malay, English, Chinese, Tamil.
Government type	Constitutional monarchy
Capital	Kuala Lumpur, with Putrajaya as administrative centre.
Administrative divisions	13 states: Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Perak, Perlis, Pulau Pinang, Sabah, Sarawak, Selangor, Terengganu and 3 Federal Territories: Kuala Lumpur, Labuan and Putrajaya.
Legal system	Based on English common law; with judicial review of legislative acts in the Supreme Court at the request of supreme head of the federation.

(source: The World Factbook, [*8* and *14*], viewed June 27, 2006)

3.2 Malaysia Land Administration

The ultimate aim of an effective land administration in general, land registration in particular, is none other than the certainty of land ownership. Land registration, the official recording of legally recognised interests in land provides legal and administrative frameworks for land. It supports conveyance, property taxation and is often the source of avenue for government to collect the various fees and taxes.

3.2.1 Background information

Land law provides a variety of rights, depending on the traditions of the country. Land use rights are often based on occupation of land over a long period and can be defined in written law or by traditions.

There are four major sources of national land law, on chronological order that include [*42*]:

- Customary law (undang-undang adat)
- Islamic law (undang-undang Islam)
- English law (undang-undang Inggeris)
- National Land Code, Act 56 of 1965 (Kanun Tanah Negara)

Historically (pre-colonial days), the Malay states had a system of land law based on customary and Islamic laws. Customary law is unwritten law established by long usage, consists of "*of established patterns of behaviour that can be objectively verified within a particular social setting*" [*57*, viewed June 20, 2006]. Examples of the customary law include those related to the Malay traditional house (e.g. Kiah bt Hanapiah v. Som bt Hanapiah, 1953. The classic case whereby the detachable traditional wooden house rested on top of stilts was considered as "*chattel*", not part of "*land*") and alimony settlement (tuntutan harta sepencarian) among partners after a divorce. Islamic law is applicable only to Muslims, examples are laws related to "*wakaf*[1]" (endowment, the dedication of any property from which its usufruct or benefits may be used for any charitable purpose) and "*hibah*" (giving one's wealth to others without the expectation of any replacement or exchange with the transferring effect on the ownership).

English law (also known as common law, especially those related to equity), on the other hand has been the legacy from the past colonial master. Equity is actually a set of legal principles to maintain natural justice whenever strict adherence of rules of law appears to be harsh.

Prior to 1966, Peninsular Malaysia had two different systems of land tenure[2]. Pulau Pinang and Melaka (or Penang and Malacca, the so called Straits Settlements) had a land tenure system tailored that of the English laws of property and conveyencing, whereby privately executed deeds were the basis of title to land. The other nine states practiced Torrens system of land title registration, where

1

Wakaf: original text in Malay "menyerahkan apa-apa harta yang boleh dinikmati manfaat atau faedahnya untuk apa-apa tujuan kebajikan".
Hibah: original text in Malay "pemberian milik oleh seorang terhadap hartanya kepada seseorang yang lain pada masa hidupnya tanpa balasan".

2

Peninsular Malaysia refers only to West Malaysia (Sabah and Sarawak excluded).

private rights in land can only be derived from an express grant by the State or via the State registration of subsequent statutory dealings.

With the introduction of the National Land Code (NLC) in 1966, there are currently three main different land legislations in Malaysia. Land matters in Peninsular Malaysia are administered under the NLC, while Sabah and Sarawak still use their own land ordinance. The Sabah Land Ordinance 1930 (Cap. 68) provides the framework for land policy in Sabah, together with the Land (Subsidiary Title) Enactment 1972 and Land Acquisition Ordinance (Cap. 69). Sarawak, on the other hand, governs its land ownership rights under Sarawak Land Code 1958 (Cap. 81), in conjunction with the Mining Ordinance 1958 (Cap. 83), Land Control of Subdivision Ordinance (Cap. 82) and Strata Titles Ordinance 1974. However, there is another land legislation that is applicable only to Pulau Pinang and Melaka. Being part of the Straits Settlements, the early land law in Pulau Pinang was based on the English system of grants, while Melaka had a mixture of English, Malay (customary) and Dutch tenures. The National Land Code (Penang and Malacca) Act was specially enacted in 1963 to facilitate the transfer of land titles under the previous system to that of Torrens System, the process that began in 1965.

3.2.2 Land legislation

Federal Constitution places land matters under the jurisdiction of state government (Federal Constitution: article 74 & 77, List II – State List of the Ninth Schedule) although Article 76(4)[3] do empower parliament to legislate for states for the purpose of "*ensuring uniformity of law and policy*". Examples of such legislatures include the National Land Code (Act 56), Strata Title Act 1985 (Act 318), Land Acquisition Act (Act 486) and Land (Group Settlement Areas) Act 1960 (Act 530).

NLC was being formulated in the 50s, based on the then Land Code 1926, updated and improved with additional new sections. It came into effect since January 1st, 1966. Over the years it remained relatively unchanged in scope and content, except sections (NLC: s.151 – s.157) that had been superseded by STA: s.83[4] (Strata Title Act, Act 318).

Sections 14, 435 and 445[5] (NLC) further provides for the State to draw up individual State Land Rules to facilitate the procedures for land application, permit application for removal of rock material, rate for conversion premium (land revenue payable when converting land use from one category to another) and also special provisions to cater for previous land ordinances.

3

Federal Constitution: art. 74. Subject matter of federal and state laws.
Federal Constitution: art. 76(4). Parliament may, for the purpose only of ensuring uniformity of law and policy, make laws with respect to land tenure, the relations of landlord and tenant, registration of titles and deeds relating to land, transfer of land, mortgages, leases and charges in respect of land, easements and other rights and interests in land, compulsory acquisition of land, rating and valuation of land, and local government.
Federal Constitution: art. 77. Residual power of legislation.

4

NLC: s.151 – 157: (deleted by STA: s.83).
STA: s.83: Repeal and amendment of provisions of the National Land Code.

5

NLC: s.14: Power of State Authority to make rules.
NLC: s.435: Rules relating to rice cultivation.
NLC: s.445: Power of State Authority to make additional transitional provisions, etc.

Definition of land

Legally, land includes any ground with any structures attached permanently to it, whether on or below the surface, all vegetation and other natural products, the airspace and also land under water (NLC: s.5[6]). Nevertheless the extent of the exclusive use and enjoyment of land is limited only to such a height and depth reasonably necessary for its lawful use and enjoyment (NLC: s.44 (a) and s.92C (1)(a)[7]). The concept of land in Malaysia perspective is the same as in *Fig. 5*.

Prior to the amendments to the NLC (notably s.151 – 157 and s.92), the rights of the proprietor of any alienated land were limited to the "*exclusive use and enjoyment of only so much of the land below that surface as is reasonably necessary to the lawful use and enjoyment of the land*". Land was previously regarded as two dimensions in term of length and breadth, without much restriction on the height and depth in the use of land (as long as the land use is lawful – consistent with the category of land use, implied or express conditions and complied with planning requirements and the local authority by-laws).

With the rapid development especially in urban areas such as Kuala Lumpur, the urgent need to maximise land use has pushed development upwards and even downwards. Development skywards has been catered for by the Strata Title Act 1985 (Act 318) while Section 92 (NLC)[8] was amended for underground development. Land can now be disposed as lot (the traditional surface parcel) but also as parcel (volume parcel in subdivided building) and stratum (cubic layer of underground land). Land can now be expressed in not only linear measures (ha or square metre), but also in cubic measures (cubic metre). Refer to *Fig.* 15 to *Fig.* 17 in §3.2.7 and §3.3.1 for a better understanding on the definition of lot, strata parcel and stratum.

Definition of land ownership

Land ownership as governed by the NLC is based on the Torrens System, where "*the register is everything*". Torrens System, a system of Land Registration devised by Sir Robert Torrens, the first Premier of South Australia and introduced in South Australia in 1858. It was being introduced to the then FMS (Federated Malay State: Perak, Selangor, Pahang and Negeri Sembilan) in the 19th century, based on that of Fiji, which in turn was a local adaptation of the then incompletely developed Australian system [*W.F.N. Bridges, 1930*]. Later on, a modified version was accepted throughout the Malay States (the 11 West Malaysia states less Malacca and Penang).

6

NLC: s.5: "**land**" includes - (a) that surface of the earth and all substances forming that surface; (b) the earth below the surface and all substances therein; (c) all vegetation and other natural products, whether or not requiring the periodical application of labour to their production, and whether on or below the surface; (d) all things attached to the earth or permanently fastened to any thing attached to the earth, whether on or below the surface; and (e) land covered by water.

7

NLC: s.44(a): the exclusive use and enjoyment of so much of the column of airspace above the surface of the land, and so much of the land below that surface, as is reasonably necessary to the lawful use and enjoyment of the land.
NLC: s.92C(1)(a): extending from such depth below the surface of such State land to such further depth below such surface.

8

STA: An act to facilitate the subdivision of building into parcels and the disposition of titles thereto and for purposes connected therewith.
NLC: s.92: Disposal of underground land.

Land ownership is protected by the NLC: s.340 (indefeasibility of title and interest) and is guaranteed by the Federal Constitution. Once an ownership is being registered, the owner's title (or interest) is indefeasible in a sense that it cannot be 'challenged or questioned' (except of course if the means of acquisition involved fraud or misrepresentation or others as listed under Section 340(2)). No person shall be deprived of property as stated under Article 13[9] of the Federal Constitution, unless the said land has been acquired in accordance to the Land Acquisition Act 1960 and that only after adequate compensation has been paid.

Land can be acquired in three ways. First to acquire through alienation from the State Authority under Section 42 (NLC), secondly is by dealings and lastly through inheritance. Alienation is the process of disposal of state land in perpetuity or a term of years, while dealings include transfers, leases, charges, easements and liens (NLC: s.5)[10]. The disposal of land by state can be done in two methods, by alienation or non-alienation method (e.g. reserve land, temporary occupational license, permit for air space etc.).

3.2.3 State authority

Section 40 (NLC) stipulates "*property in State land, minerals and rock material shall be vested solely in the State Authority*". State Authority in this case refers to the Ruler or Governor, under the advice of the State Executive Council. State Authority has the powers to alienate state land, reserve state land and grant leases of reserved land, permit temporary occupation of state land, reserved land and mining land, permit extraction and removal of rock material from any land other than the reserved land and also permit the use of air space over state land or reserved land. Alienation in the form of mining lease is however governed under the Mining Enactment.

Article 91 of the Federal Constitution further provides for the establishment of National Land Council, to formulate a national policy for the promotion and control of the utilisation of land throughout the country for mining, agriculture, forestry or any other purpose in consultation between the Federal and State Governments. It is mandatory for both the Federal and State Governments to follow the policy formulated by National Land Council.

9

NLC: s.340: (1) The title or interest of any person or body for the time being registered as proprietor of any land, or in whose name any lease, charge or easement is for the time being registered, shall, subject to the following provisions of this section, be indefeasible. (2) The title or interest of any such person or body shall not be indefeasible - (a) in any case of fraud or misrepresentation to which the person or body, or any agent of the person or body, was a party or privy; or (b) where registration was obtained by forgery, or by means of an insufficient or void instrument; or (c) where the title or interest was unlawfully acquired by the person or body in the purported exercise of any power or authority conferred by any written law.
Federal Constitution: art. 13: (1) No person shall be deprived of property save in accordance with law. (2) No law shall provide for the compulsory acquisition or use of property without adequate compensation.

10

NLC: s.5: "**alienate**" means to dispose of State land in perpetuity or for a term of years, in consideration of the payment of rent. "**dealing**" means any transaction with respect to alienated land effected under the powers conferred by Division IV, and any like transaction effected under the provisions of any previous land law, but does not include any caveat or prohibitory order. "**state land**" means all land in the State (including so much of the bed of any river, and of the foreshore and bed of the sea, as is within the territories of the State or the limits of territorial waters) other than (a) alienated land; (b) reserved land; (c) mining land; (d) any land which, under the provisions of any law relating to forests (whether passed before or after the commencement for this Act) is for the time being reserved forest. "**reserved land**" means land for the time being reserved for a public purposes in accordance with the provisions of section 62 or any previous land law.

Land administration within the state falls under the state Director of Lands and Mines Department (PTG) at state level and District Land Offices at the district level. The Department of Director General of Lands and Mines (JKPTG) under the Ministry of Natural Resources and Environment (NRE) plays an important role in coordinating land administration at the federal level. JKPTG works closely with all the state PTG. NRE was established in 2004 to streamline the functions over the management of the nation natural resources, environment conservation and management and also land administration. It has ten departments / agencies, among them are the JKPTG and the national mapping agency (Department of Survey and Mapping Malaysia or JUPEM).

Land administration, either at the state or district levels, is generally responsible for the following activities:

- Manage application for land and dealings
- Collection of land revenue
- Manage land title registration
- Manage application for land development

And

- Enforce land rules and regulations

Generally it comprises the processing for application for land, issue of document of title, registration of strata, registration of dealings such as transfer (land or interests in land), lease, charge, certificate of sale, granting or releasing of easement and change of condition of land use, subdivision, partition or amalgamation of land, subdivision of building, and collection of land revenue, etc., not excluding the enforcement of land laws.

Although NLC provides the fundamental legal framework for the above activities, it needs to be read in conjunction with other complementary instruments. Examples are the various circulars and guidelines issued by the JKPTG from time to time. These instruments serve to provide further clarification over the legal provisions and also to standardise working procedures.

3.2.4 Land title registration

Peninsular Malaysia still practices dual land registration system, one for the registry title and another for the land office title[11]. There are six types of title, depending on the location (Town, Village or Country[12]), the size (greater or less than 4 ha), the term (in perpetuity or for a term of years) and whether the land has been surveyed. Titles can be in the form of state grant, state lease

11

NLC: s.5: "**Registry title**" means title evidenced by a grant or State lease, or by any document of title registered in a Registry under the provisions of any previous land law. "**Land Office title**" means title evidenced by a Mukim grant or Mukim lease, or by any document of title registered in a Land Office under the provisions of any previous land law.

12

NLC: s.5 & s.51(2): (a) town land, that is to say, land in any area of the State declared in accordance with the provisions of section 11 to be a town or, by virtue of section 442, deemed to be a town duly constituted as such under those provisions; (b) **village land**, that is to say, land in any area of the State declared in accordance with the provisions of section 11 to be a village or, by virtue of section 442, deemed to be a village duly constituted as such under those provisions; (c) **country land**, that is to say, all land above the shore-line other than town land village land.
NLC: s.11: The State Authority may by notification in the Gazette- (a) divide the territory of the State into districts; (b) divide any district into sub-districts; (c) divide any district or sub-district into mukims; (ca) vary or alter the boundary of any district, sub-district, mukim, town or village; (d) after the survey or definition thereof by or on behalf of the Director of Survey, declare any area of the State to be a town or village.

and qualified title, or mukim grant, mukim lease and qualified title (also known as mukim qualified title). The first three being the registry titles, others the land office titles. Grant is holding in perpetuity, lease only for a term of years while qualified title is title issued prior to final survey (see footnote 14).

Dealings involving registry titles can only be registered at the respective Registry Office (PTG, Pejabat Tanah dan Galian or state Lands and Mines Department, one state has only one such office), while those involving land office titles are at the respective Land Office (PTD, Pejabat Tanah Daerah or District Land Office, one at very district or sub-district).

3.2.5 Cadastral survey in Malaysia

In Malaysia, cadastral survey is under the jurisdiction of federal government. The Department of Survey and Mapping (JUPEM), under the Ministry of Natural Resources and Environment (NRE) is the federal department responsible for carrying out land surveying and mapping. The coming into effect of the Licensed Surveyors Ordinance 1958[13], allows non-government surveyors licensed by the Land Survey Board to practise privately in the execution of surveys for title. This was to encourage a gradual transfer of responsibility for executing title surveys to a private professional body, while government retaining its rights to control such activities.

Sabah and Sarawak have a different arrangement. Under the terms of the Inter-Government Committee Report 1962 and Chapter 8 of the Federal Constitution, land and cadastral survey are state subjects. For these two states, the Department of Land and Surveys control both the state land administration and cadastral surveys. Nevertheless, the responsibility for carrying out topographical and geodetic survey in Sabah and Sarawak remains with JUPEM (Inter-Government for Ministry Committee Report 1975).

Cadastral mapping has been providing vital land information ever since the colonial days. The cadastral maps from the national survey and mapping agency - JUPEM, providing digital information on land parcels such as parcel numbers, its geometry and dimensions. All information about land is basically two-dimensional in nature.

3.2.6 Department of Survey and Mapping Malaysia (JUPEM)

According to JUPEM website [*15*], the first independent survey department, was established in the state of Johore in 1885, although the federal level survey department was formed only in 1909. Prior to that, land survey was carried out by other agencies such as Public Work Department, State Land Office and the licensed surveyors contracted from Australia.

The function of JUPEM is to "*provide an efficient and high quality system of land survey and mapping services and geospatial information as a catalyst for national development and the well-being of the citizens*" (JUPEM's mission statement). It is headed by the Director General of Survey

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Licensed Land Surveyors Act 1958: an act relating to the licensing and control of land surveyors whereby - a licensed land surveyor shall be entitled to practise his profession as a land surveyor and shall be authorised to undertake title surveys.

and Mapping who acts as the Director of National Mapping Directorate and Director of Military Mapping. It has two main divisions, each with the following functions:

- Mapping Division – to publish and print maps and establish National Topographical and Cartographic databases, include also the determination, demarcation and survey of international land or maritime boundaries
- Cadastral Division – to plan and monitor land title survey works, modernization of cadastral survey, overseeing Licensed Surveyors activities, research and review policies and as well as its implementation

At state level, the role of the State Survey and Mapping Departments is to carry out the activities of title survey, involving land, building and underground surveys for the purpose of issuance of land, strata and stratum title. There are currently fifteen state JUPEM, one each for the thirteen states, one for Federal Territory of Labuan and a combined office for Federal Territories of Kuala Lumpur and Putrajaya.

3.2.7 Cadastral survey

Section 10 (NLC) authorised the Minister (NRE) to prescribe procedures to be adopted by JUPEM and the powers and duties of its officers when carrying out survey for title in accordance to Section 396[14] of the same act. The standard procedures that govern cadastral surveys are described in great detail in Survey Regulations 1976 and the various Director General Circulars (DG Circulars). These regulations and instructions need to be strictly adhered to while carried out the title survey, the private licensed land surveyors included.

Geodetic Datum: cassini-soldner and rectified skew orthomorphic

There are currently two map projection systems in the Peninsular Malaysia – Cassini-Soldner (or Cassini) for cadastral survey while Rectified Skew Orthomorphic (RSO) for mapping purposes. Cassini projection system is a cylindrical, tangential, transversal, equidistant and semi-geometrical projection, with no distortion in area and shape along the central meridian. Distortion however, increases with distance away from this central meridian. Hence this plane coordinates system is suitable for relatively small areas. There are in fact ten state Cassini coordinate systems in peninsular, each with its own origin and each state is being considered as an independent plane surface, without taking earth curvature into consideration. On the other hand, RSO projection system is an 'ellipsoidal oblique Mercator' projection with constant minimum scale error along a great circle passing obliquely through the peninsular. The scale error increases with distance away from this great circle.

14

NLC: s.10: Regulation of procedure, etc., of Survey Department.
NLC: s.396: Land shall not be taken to have been surveyed until - (a) its boundaries have been determined by right-lines; (b) every stratum lot shall be defined by regular planes which may be horizontal or inclined fixed by reference to reduced levels; (c) the volume of the stratum of the underground land enclosed by its boundaries as so determined has been calculated; (d) a stratum lot number has been assigned thereto by the Director of Survey and Mapping; and (e) a certified stratum plan, showing the situation of the stratum, the position of its boundaries as so determined and such boundary marks as may be required and the volume and stratum lot number thereof, has been approved by the Director of Survey and Mapping.

Concept of lot (land parcel)

Under Torrens System, the boundaries of each parcel of land (lot) are defined by coordinates, bearings and distances (of each surveyed line) as well as the area of the lot. Lot can be defined either by physical demarcation on the ground (turning points marked by boundary marks[15]) or described mathematically based on a coordinate system. Straight lines joining those marks defined the boundary limits of the lot.

Survey Regulations 1976 [*52*] classifies surveys according to the degree of accuracy and methods used, divided into first class, second class and third class of survey. 1st class surveys are required for the control of 2nd class or other surveys and include title surveys for town and village land. 2nd class surveys are for title survey in country areas not surveyed by 3rd class method, while 3rd class surveys comprise survey of the internal boundaries of group surveys in country land with external boundaries controlled by 2nd class surveys. For division of land into town, country and village, see footnote 12.

The cadastral map provides information for identification of land parcels for survey and land administration. The authenticated cadastral map (certified plan or CP) depicts technical data (e.g. bearings, distances and the 2D coordinates of 2 extreme boundary marks), and also other relevant information when dealing with strata and stratum alienations. The strata plan (for building with two or more storeys) contains not only the parcel information where the multi-storey building resides, but also additional information on the storey height of the building and the strata parcels. Likewise, the stratum plan provides the additional depth information of the underground volumetric parcels. The examples of certified plan for the surface lot, strata and stratum parcel are shown in the following diagrams:

15

NLC: s.4: "**boundary-mark**" includes any survey stone, iron pipe or spike, wooden peg or post, concrete post or pillar or other mark used for the purpose of marking boundaries.

Fig. 15: Sample certified plan in CAD format (courtesy Jurukur Nusantara).

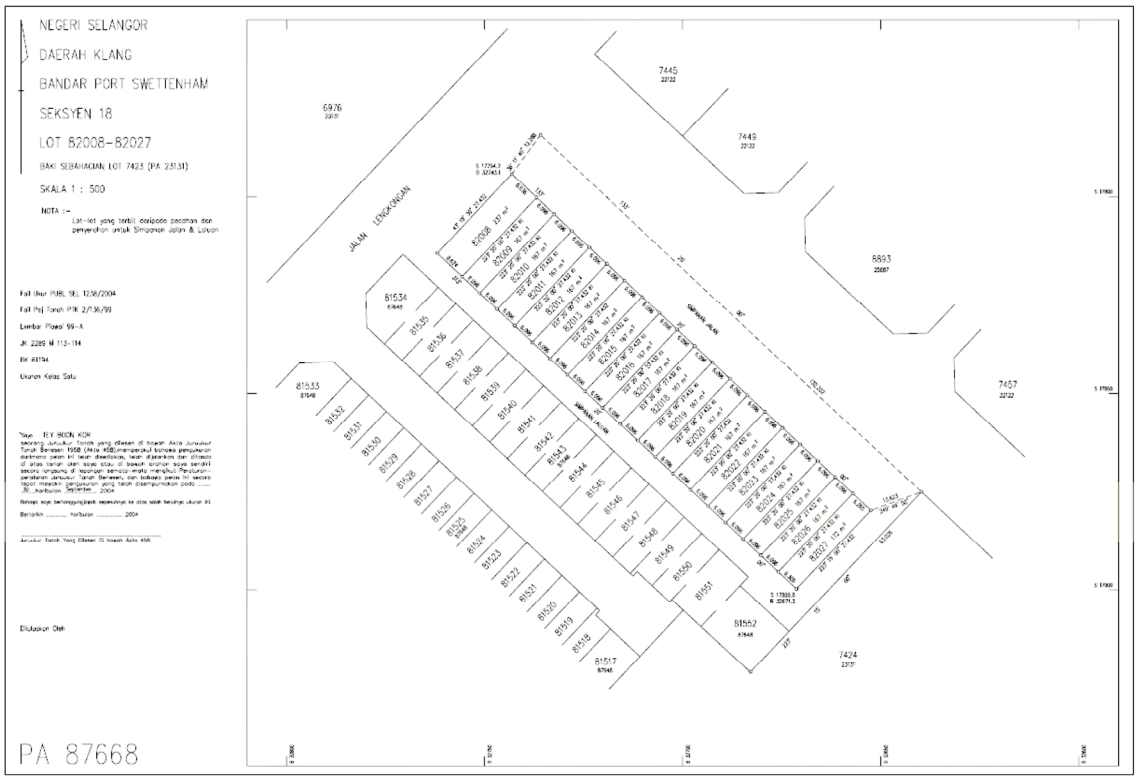


Fig. 16: Sample strata plan in CAD format (courtesy Jurukur Nusantara).

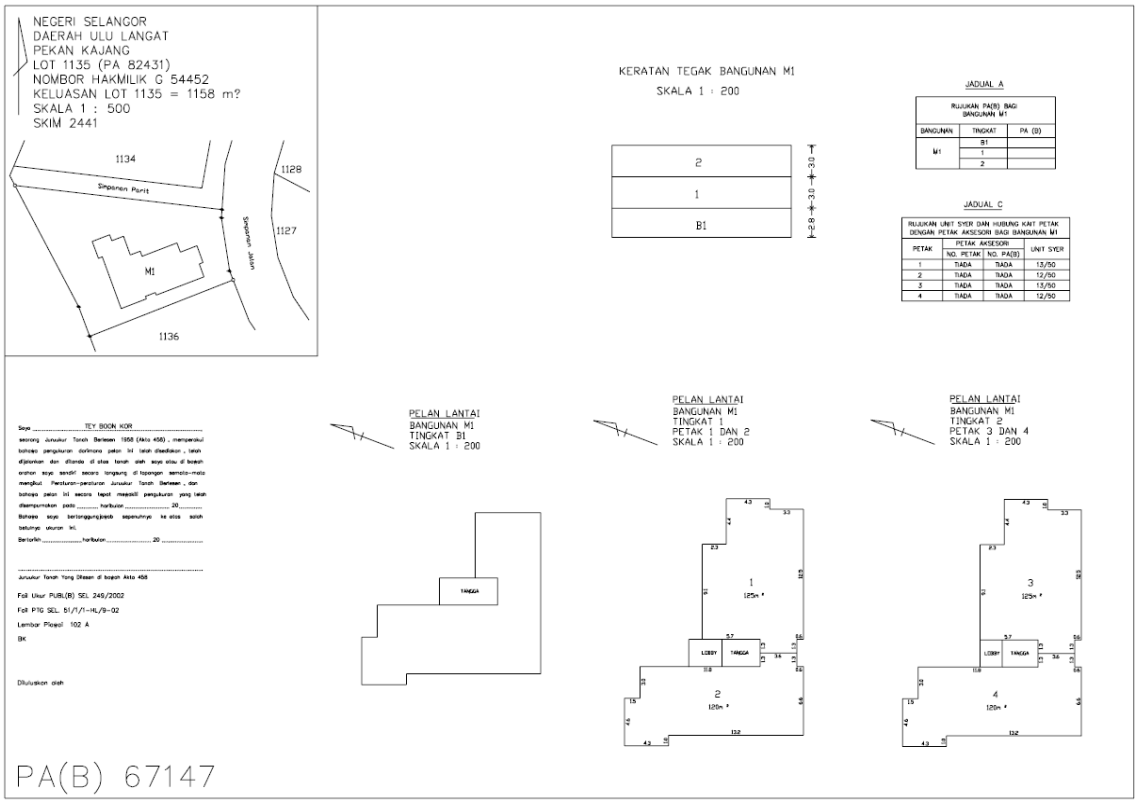
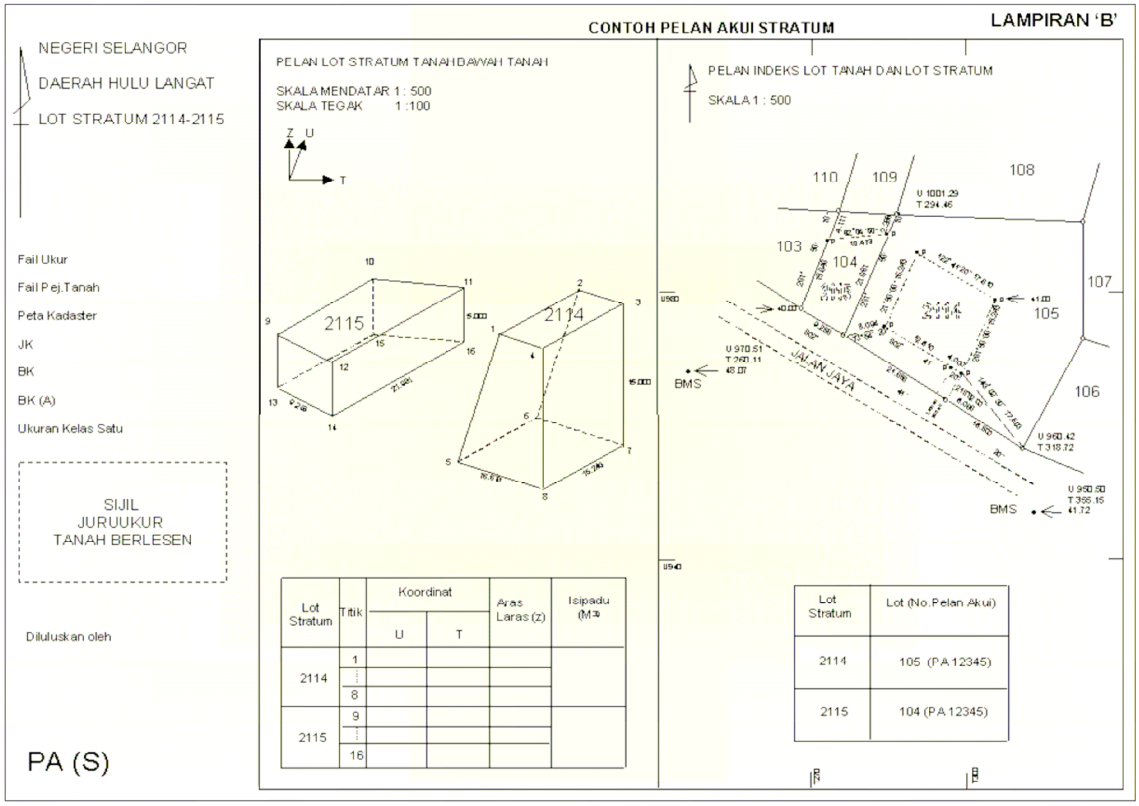


Fig. 17: Sample stratum plan and related information (source: JUPEM).



3.3 Cadastral Data Model

The current Malaysia cadastral data model can be illustrated by the same UML class diagram as in *Fig.11* (see §2.4.1), which exemplified the relationships between the three core classes – the RegisterObject (the real property objects), Person (or subject) and RRR (right, restrictions, responsibilities).

3.3.1 Current cadastral data model

The definition of these three core classes can be derived from the NLC as:

Persons (NLC: s.43)

- Natural persons (excluding minors less than 18 years old)
- Corporations, sovereigns, governments or organisations
- Persons authorised to hold land under the Diplomatic and Consular Privileges Ordinance 1957
- Bodies expressly empowered to hold land (e.g. Trade union Ordinance 1957)

RegisterObject

- Lot (land parcel) (NLC: s.5[16])
- Parcel (building parcel) (STA: s.4)
- Stratum (underground volume) (NLC: s.92A)

RRR

- Rights (e.g. extent of general disposal under NLC: s.44 (footnote 7))
- Responsibilities (duty to pay rent – e.g. survey fees, premium, annual quit rent etc.)
- Restrictions (e.g. category of land, express and implied condition etc.)

3.3.2 Cadastral database

With the advent of information communication and technology (ICT) and in line with the government objective of providing efficient and quality land administration services to the public, various applications have been enhanced and developed.

For example, PTG has computerised two of its main operations in land administration via Land Revenue Collection System (SPHT) and Computerised Land Registration System (SPTB). On the other hand, JUPEM has implemented a data collection and processing facility - the CATMAPS system for mapping activity and the Automated District Survey Office System (SAPD) and also the Cadastral Data Management System (SPDK) for its cadastral activity. Both SPTB and SPDK enabled the process of land measurement and registration of ownership to be accelerated, while the Malaysia Geospatial Data Infrastructure (MyGDI) facilitated the exchange and sharing of spatial and non-spatial information.

Computerised Land Registration System (SPTB)

SPTB is a system to modernise and to facilitate registration of land title and dealings. Data are extracted from both the documents of title and other land related documents. Land related information could be accessed from terminal located at the state Registry Office as well as all the District Land Offices within the state. However, all dealings in land can only be registered at the respective Registry Office or District Land Office (depends on where the title was formerly registered, see also §3.2.4).

The process of recording rights in land via registration of title to land enables any person acquiring a property in good faith can trust the information published in the register. The register furnishes all information pertaining to the ownership (person), the land (object, through description of area and location and boundary limit from the CP) and rights (details of encumbrance, expressed conditions, caveats and prohibitory orders etc). However, not all restrictions are stated in the register, some are implied by law (e.g. NLC, planning controls etc). These registers are now digitally accessible under the Computerized Land Registration System throughout the states.

16

NLC: s.5: "**lot**" means any surveyed piece of land to which a lot number has been assigned by the Directory of Survey.
STA: s.4: "**parcel**", in relation to a subdivided building, means one of the individual units comprised therein, which (except in the case of an accessory parcel) is held under separate strata title.
NLC: s.92: "**stratum**" means a piece of underground land (land which lies below the surface of the earth).

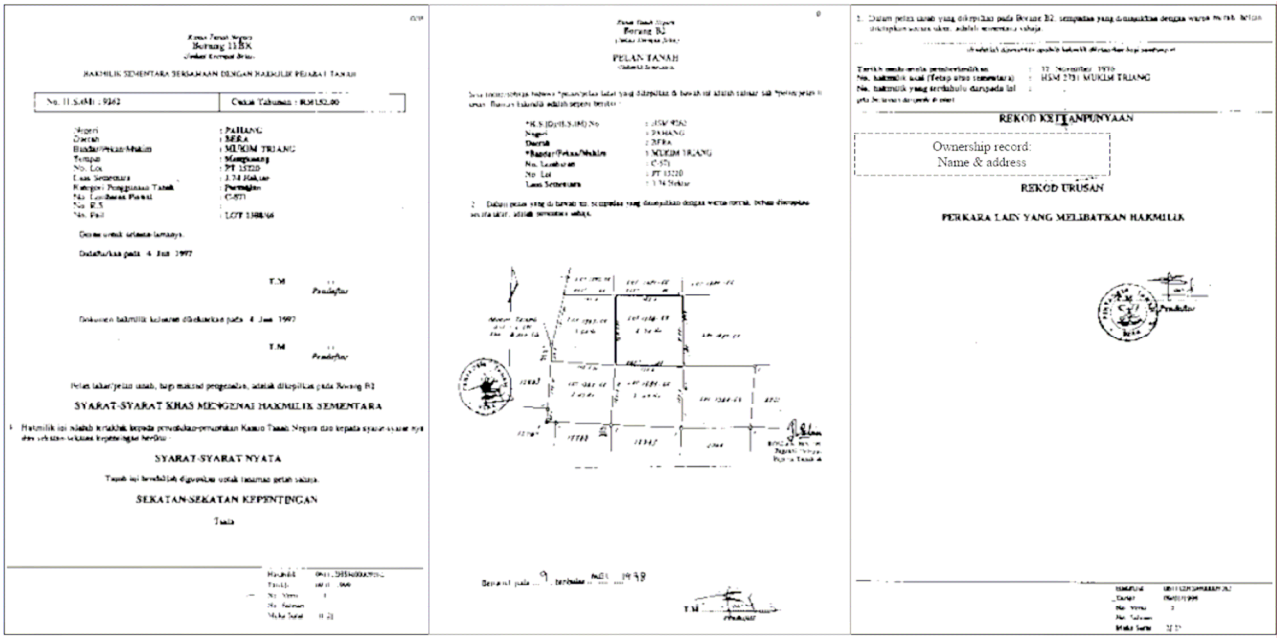
Nevertheless, though current legislation provides volumetric parcel alienation (i.e. strata and stratum parcel), existing registration is still based entirely on (surface) land parcel without necessarily expressing the associated depth or height.

SPTB produces the following official documents:

- Computerised register document of title (dokumen hakmilik daftar komputer) or DHDK
- Issued computerised register document of title (dokumen hakmilik keluaran komputer) or DHKK
- Official search
- Verification document
- Other land referencing information

DHKK is actually the duplicate copy of DHDK, the formal is issued to the respective owner and the latter kept in the Land Office strong room for future references. Sample copy of land title is shown as below and in Appendix C1 – C4:

Fig. 18: Sample of Land Office's DHKK (3 pages).



Cadastral Data Management System (SPDK)

The aim of SPDK is to create a Digital Cadastral Data Base (DCDB) in conjunction with a certified plans image library. DCDB holds digital cadastral basemaps that are used for building GIS and land related applications, while the image library holds scanned and indexed CPs stored in disk arrays at every state JUPEM.

SPDK has four main subsystems, the first two produce the DCDB and digital image library, the next two to access and download data for fees:

- SPEK (Quality assurance system) – modules to preserve the integrity, currency and accuracy of DCDB
- SPID (Document image management system) – modules to create and maintain a digital library of certified plan images that allow user to search, view, print on demand from JUPEM intranet and internet
- Counter service – modules for easy access to cadastral data via online search, touch screen browser, print on demand, electronic payment system and internet accessible
- E-commerce – provide an interactive and informative website, which cater for search from virtual catalogue and instant downloading of digital data

The following work flow diagrams show the processes in the creation of DCDB and SPID, as well as sample cadastral map from DCDB and scanned image of CP:

Fig. 19: Workflow within SPDK and the process of creating DCDB and digital image library in state JUPEM (source: [*15*], viewed June 08, 2006)

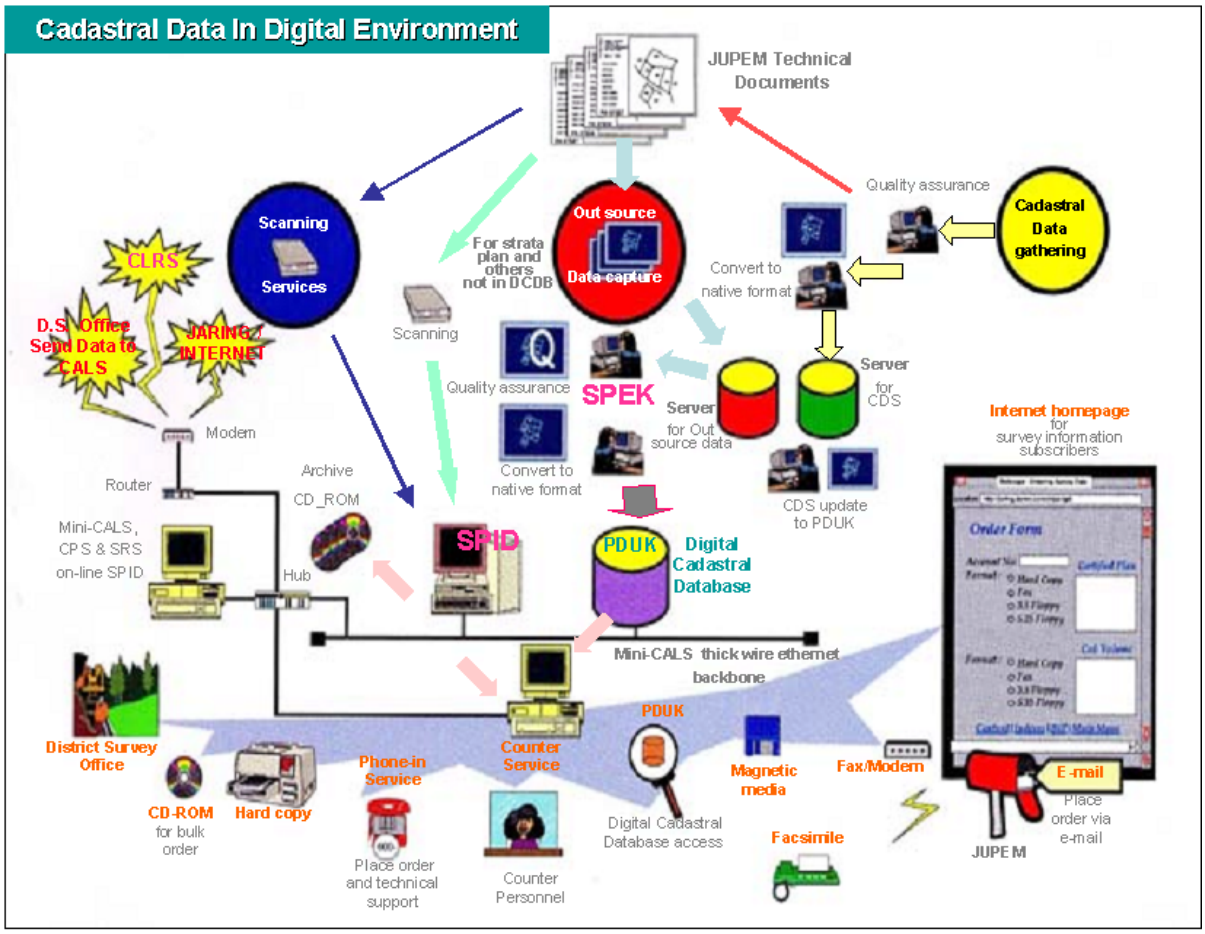


Fig. 20: Sample cadastral map from survey accurate DCDB [*10*].

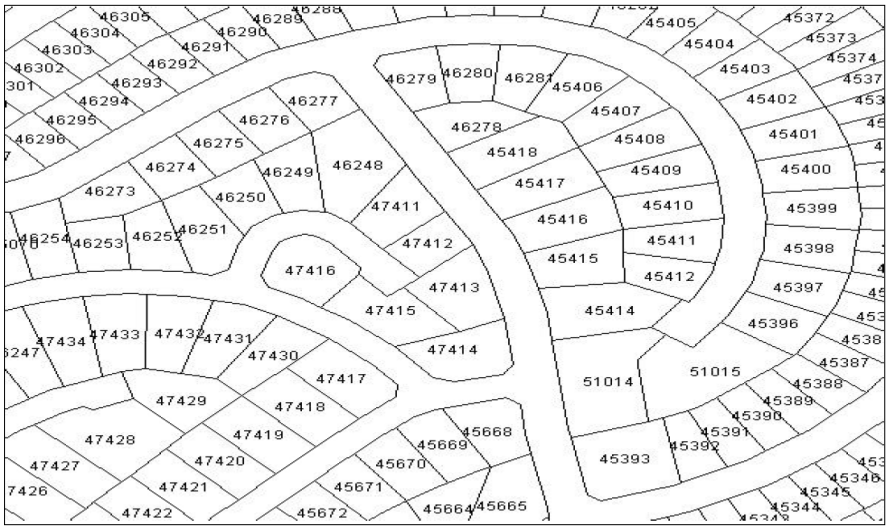
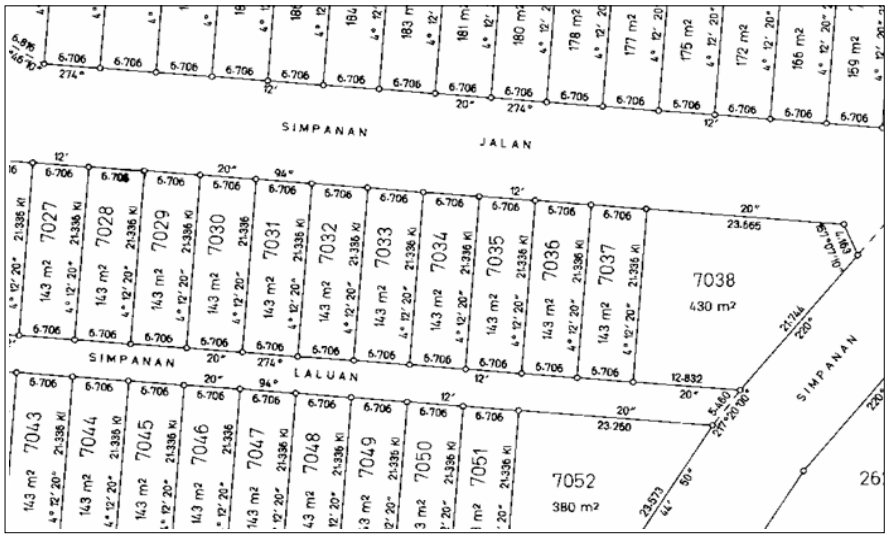


Fig. 21: Sample scanned image of certified plan [*37*].



3.3.3 Cadastral data structure

The Digital Cadastral Data Base (DCDB) was established to collaborate and to integrate with the Computerised Land Registration System (SPTB). DCDB, together with SPTB form a complete and comprehensive large-scale land information system. The data structure for both DCDB and SPTB are being listed as below:

Table 2: Data structure of Digital Cadastral Database (source: JUPEM, DCDB table version 550).

Table	Attribute	Attribute Type	Description	Spatial Object
Boundary mark (STN)	UPI	Char (16)	Unique Parcel Identifier[17]	**Point**
	PA	Char (15)	Certified Plan number	
	CLS	Char (1)		
	Apdate	Char (8)	Certified Plan approved date	
	Pointkey	Char (55)		
	MarkDesc	Char (13)	Boundary mark type	
	Serial	Char (8)	Boundary mark serial number	
	Coord_Type	Char (1)	Coordinates type - rigid or plotting	
	North	Char (12)	Northing	
	East	Char (12)	Easting	
	M_North	Char (20)		
	M_East	Char (20)		
	G_North	Char (20)		
	G_East	Char (20)		
	S_Comment	Char (45)		
	Unit	Char (1)	Unit - metre, ling or feet	
	EntryMode	Char (1)	Data entry mode	
	Ordered	Char (3)		
	Updated	Date	Updated date	
	GUID	Char (32)		
	MI_PRINX	Decimal (13,0)		
Boundary line (BDY)	UPI	Char (16)	Unique Parcel Identifier	**Polyline**
	Bearing	Char (9)	Bearing	
	Distance	Decimal (14,3)	Distance	
	M_Bearing	Float		
	M_Distance	Decimal (14,3)		
	G_Bearing	Char (9)		
	G_Distance	Decimal (14,3)		
	Unit	Char (1)	Unit - metre, ling or feet	
	CLS	Char (1)		
	LineCode	Char (2)	Boundary line code	

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Unique Parcel Identifier (UPI): State code (Char (2)) + District code (Char (2)) + Mukim code (Char (2)) + Section code (Char (3)) + Lot number (Char (7)).

	LineType	Char (1)	Boundary line type	
	Fnode	Char (55)		
	Tnode	Char (55)	Data entry mode	
	PA	Char (15)	Certified Plan number	
	Apdate	Char(8)	Certified Plan approved date	
	EntryMode	Char (1)	Data entry mode	
	F_Stn_Ordered	Char (3)		
	T_Stn_Ordered	Char (3)		
	FromNodeGUID	Char (32)		
	ToNodeGUID	Char (32)		
	Ordered	Char (3)		
	Updated	Date		
	GUID	Char (32)		
	MI_PRINX	Decimal (13,0)		
Cadastral Lot (LOT)	Negeri	Char (2)	State code	**Polygon**
	Daerah	Char (2)	Second administrative area (District) code	
	Mukim	Char (2)	Third administrative area (Mukim) code	
	Seksyen	Char (3)	Fourth administrative area (Section) code	
	Lot	Char (7)	Lot number	
	UPI	Char (16)	Unique Parcel Identifier	
	S_Area	Decimal (20,3)	Surveyed Lot area	
	M_Area	Decimal (20,3)		
	G_Area	Decimal (20,3)		
	Unit	Char (1)	Unit - metre, ling or feet	
	PA	Char (15)	Certified Plan number	
	RefPlan	Char (15)		
	Apdate	Char (8)	Certified Plan approved date	
	CLS	Char (1)		
	LandUseCode	Char (2)		
	LandTitleCode	Char (2)		
	EntryMode	Char (1)	Data entry mode	
	Updated	Date	Updated date	
	GUID	Char (32)		
	MI_PRINX	Decimal (13,0)		

Table 3: Data content of Computerised Land Registration System
(data structure not available, adapted from G. Mariappan, 2006 [*22*]).

Entity	Description	Original Texts in Malay
Document of title	Type of document of title	Jenis hakmilik tanah
	Certified Plan approved date	Nombor hakmilik
	State code	Negeri
	Second administrative area (District) code	Daerah
	Third administrative area (Mukim) code	Bandar / Mukim / Pekan
	Fourth administrative area (Section) code	
	Type of land use	Jenis kegunaan tanah
	Type of ownership	Jenis pemilikan
	Terms of years or in perpetuity	Tempoh pemilikan
Land identification	Lot number	
	Lot area	Keluasan
	Standard sheet number	Nombor syit piawai
	Certified Plan number	Nombor Pelan Akui
Restriction in interest	Express condition	Syarat nyata
	Restriction in interest	Sekatan kepentingan
Ownership record	Name of owner	
	National Registration Identity Number	
	Nationality	
	Address	
	Date of first alienation	
	Other dealings	Lain-lain urusan tanah
Persons and bodies having interests in land	Type of interest	Jenis kepentingan
	Name of persons having interest in land	
	National Registration Identity Number	
	Nationality	
	Address	
Title Plan	Form B1 for final document of title	
	Form B2 for qualified title	
Quit rent	Annual quit rent	Kadar cukai tanah
Dealings	Transfer	Pindah milik
	Change of condition	Tukar syarat
	Subdivision	Pecah sempadan
	Partition	Pecah bahagian
	Memorial	
	Power of attorney	Surat kuasa wakil
	Surrender	Perserahan
	Land acquisition	Pengambilan Tanah
	Charge	Gadaian
	Lease	Pajakan
	Easement	Isemen
	Other registrable transactions	Lain-lain urusniaga berdaftar

3.3.4 3D representation

The existing land legislation does provide for the registration of 3D spatial unit. The adjudication of boundaries for strata and stratum parcels are determined in the field and recorded into field records in (x, y, z or x, y, height). The third dimensions were also represented in the subsequent authentic 2D certified plans. Nevertheless the cadastral survey database (DCDB) maintained only the graphic attributes for the 2D surface lot, within which the strata or stratum spatial parcels are situated. So current cadastral system is basically only in 2D+1D, there is no direct linkage between the legal and administrative information and the relevant 3D geographic entities.

Table 4: Development that required 3D representation
(source: National Property Information Centre and online newspapers).

Item Description	Location	Quantity	Unit	Cost (billion RM)	Status	Remark
High rise construction						
Town House	Nationwide	29,433	parcel	NA	See note 1	Total supply in Year 2005.
Cluster	Nationwide	26,951	parcel	NA	See note 1	Total supply in Year 2005.
Low cost flat	Nationwide	566,486	parcel	NA	See note 1	Total supply in Year 2005.
Flat	Nationwide	426,876	parcel	NA	See note 1	Total supply in Year 2005.
Service apartment	Nationwide	45,543	parcel	NA	See note 1	Total supply in Year 2005.
Condominium / Apartment	Nationwide	574,153	parcel	NA	See note 1	Total supply in Year 2005.
TOTAL		**1,669,442**				
Underground Construction						
Plaza Putra	Kuala Lumpur	NA		NA	Completed	Underground food, leisure cum entertainment complex on government reserved land.
Utility cable & pipeline	Nationwide	Unknown		Unknown		Mostly on government reserved land.
TOTAL						
Metro						
Kelana Jaya Line	Kuala Lumpur	29.0	km	5.380	Completed	Combination of elevated & underground track on government reserved land.
Ampang & Sri Petaling Line	Kuala Lumpur	27.0	km	3.243	Completed	Elevated track on government reserved land.
KL Monorail	Kuala Lumpur	8.6	km	1.800	Completed	Straddle-beam elevated monorail on government-reserved land.
Putrajaya Monorail	Putrajaya	18.0	km	0.368	Under construction	Straddle-beam elevated monorail on government-reserved land.
LRT expansion	Klang Valley	50.0	km	7.000	2007 - 2010	NA.
Penang Monorail	Penang	37.0	km	1.100	Proposed	NA.
Johor Monorail	Johor Bahru	12.5	km	1.300	Planned 2007	NA.
TOTAL		**182.1**		**20.191**		

Note:
1. Total supply included existing stock, completion, incoming supply, under construction and starts, bulk of which concentrated in FT Kuala Lumpur, Selangor, Johor, Pulau Pinang and Negeri Sembilan (source: Table 1.1: Summary of supply of residential units type in Malaysia, Residential Property Stock Report, National Property Information Centre (NAPIC), 1st Quarter 2006). Detailed information on non-residential high-rise construction was not available.
2. Information about Metro sourced from online newspapers such as The Star, New Straits Times, and Sun etc.
3. NA- Information not available.

Fig. 22: Examples of modern constructions with vertical component.

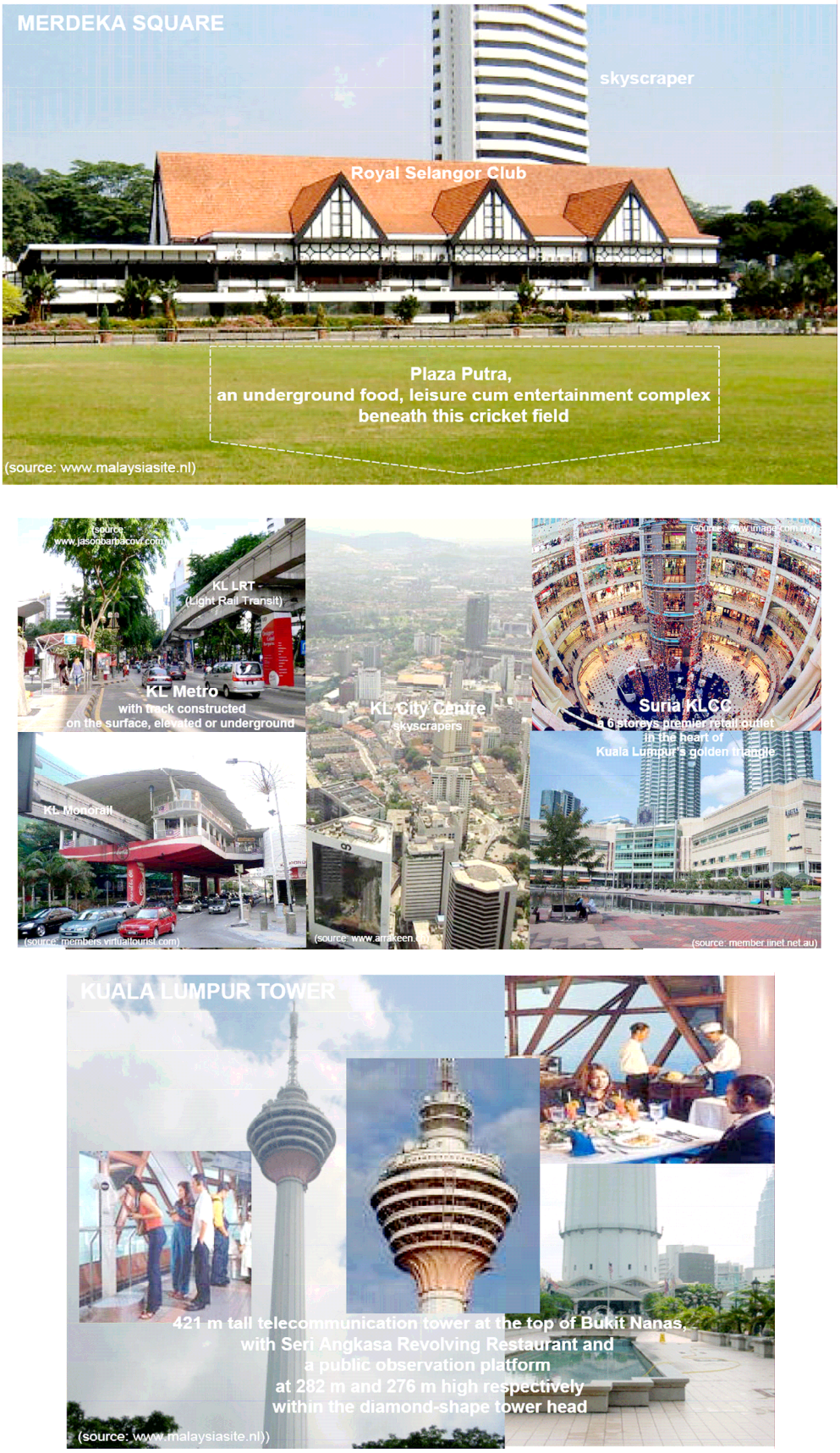
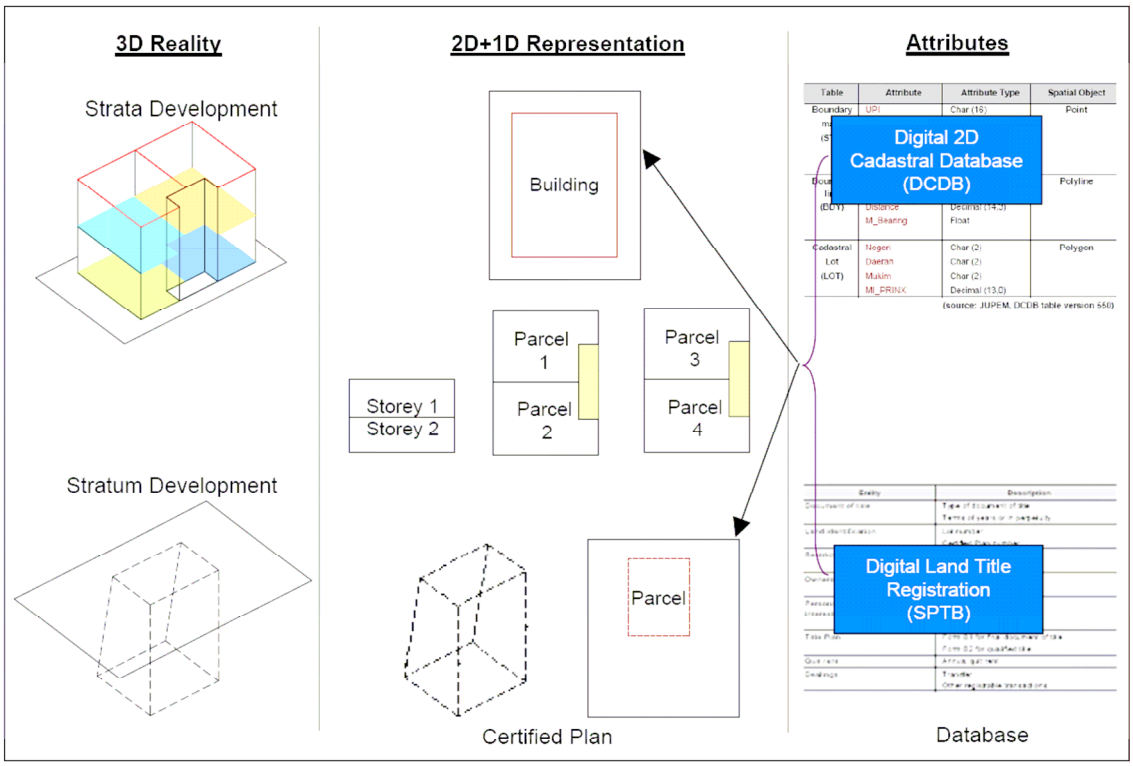


Fig. 23: Strata and stratum developments represented under current cadastre (adapted from [*39*]).



3.4 Issues related to Land Administration

The following are the major issues related to land administration in general, cadastral registration in particular. Identification of these issues shall facilitate the subsequent SWOT analysis of current registration system. It shall reveal the need to integrate the existing standalone SPTB and DCDB databases.

3.4.1 Huge backlog of qualified titles

Qualified titles (QT) are titles issued prior to final survey. Strict rules and procedures need to be followed when carrying out the final survey for title, from marking the boundaries with boundary marks (NLC: s.396[18]) to preparation of certified plan (NLC: s.410). The title plan shown on the

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NLC: s. 396: Manner in which survey is to be carried out (see also footnote 14).
NLC: s. 410: Nature of deposited plan.
NLC: s. 176(2): Qualified title shall confer on the proprietor the like rights in every respect as those conferred (as mentioned in section 92) by final title, save that - (a) the boundaries of the land shown on the document of title thereto shall be provisional only except so far as any of them may have been established by any earlier survey.
NLC: s. 4: "**final title**" means Registry title, Land Office title and subsidiary title (that is to say, all forms of title other than qualified title).

document of title is prepared from this certified plan. QT was being introduced in the 60's to overcome the slow pace of registration of final titles (NLC: s.4) due to the lack of qualified land surveying personnel. This measure aims to accelerate land administration involving subdivision development. NLC: s.176 stipulates that QT confers the same rights in every respect as the final title (FT), saved that the boundaries shall be provisional as far as that established by the earlier survey.

Although the issuing of QT was successful in expediting land development, hence promoting an active land market, but the slow process of converting QT to FT by land office has resulted in a huge backlog. Lack of incentive to convert (QT is as good as FT in term of document for security) further aggravates the matter. A study by Yidris [*62*] shown that there are as many as 2,940,075 QT in backlog (2002 figure), as compared to 1,700,000 in 1992.

Currently the lot attributes for QT are captured within the GLMS (GIS Layer Management System), together with lots surveyed via demarcation or 3rd class survey, town and village boundaries, connection lines and other text attributes such as road name. This is kept outside the current Survey Department's DCDB. Nevertheless, proper preparation of RS (Requisition for survey) by qualified personnel whereby title plan is extracted from pre-computation plan (precise mathematical computation based on previous survey boundaries), or RS based on a preliminary demarcation survey instead of sketched or scaled diagram under current Land Office practice shall be able to resolve many of the issues surrounding the differences between QT and FT.

3.4.2 Incomplete DCDB

DCDB database is incomplete as it contains only data for 1st and 2nd class surveyed lots. Lots demarcated via 3rd class survey, QT, and lots with natural boundaries or land under temporary occupation (NLC: s.65(1)[19]) as well as attributes on names of road, administrative area (e.g. town, village) etc are not available. Some of these are being captured (at later stage) in JUPEM's GLMS, or are available only within the Land Office's SPTB or other documents.

The cadastral DCDB is not compatible with the topographical details as both adopt different coordinate systems. The cadastral map is based on Cassini projection while topographical mapping uses RSO projection. The inherent characteristic of Cassini also brings about the non-homogeneous state DCDB, each with different coordinate system resulting common boundaries do not match at borders.

JUPEM is in the process of implementing the CCS (Coordinated Cadastral System), to introduce a common national coordinate system with GDM 2000 as the geodetic datum and Geocentric Cassini and RSO as the projection system [*23*]. A unified coordinate system provides a homogeneous geodetic infrastructure in the acquisition of both the cadastral and mapping data, and the subsequent integration of various spatial data as source of information to promote sustainable development. CCS should also facilitate the maintenance, upgrade and update of DCDB within the state, then across borders for an eventual national DCDB or NDCDB.

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NLC: s.65(1): The State Authority may, in accordance with the provisions of this Chapter and of any rules under section 14, permit the temporary occupation under license of – (a) State land; (b) mining land not for the time being used for the purposes of mining; (c) reserved land not for the time being used for the purposes for which it was reserved.

3.4.3 Coordination between federal level and state level

Cadastral survey is a federal responsibility for Peninsular Malaysia but land registration is strictly a state matter. Sabah and Sarawak also have different institutional arrangements for land administration, each with its own land and survey department under one roof.

Although all states operate under Torrens System of land registration, administered by the state Department of Lands and Mines (PTG) while coordinated by the federal Department of Director General of Lands and Mines (JKPTG), yet the level of coordination leave much for desire. Issues raised during the National Land Council (NLC) are mainly from the federal government perspective, which are quite often objected by the states, especially those related to federal reserved land, land revenue and land premium. The problem of a unified legislation but with different set of rules and regulations in practice can be avoided only if there is close collaboration. Also, currently there exist no legal method to enforce compliant (even though Article 91 of Federal Constitution stipulated that compliant to policies formulated by the National Land Council is mandatory).

3.4.4 Restrictive land legislation

Existing land legislation provides inadequate legislative provision to govern and guide the successful implementation of existing and future land development concepts, usually associated with the vertical component. Examples are the stratified development and gated communities.

Technological advances have made it possible to have many different types of uses simultaneously above and below one another. There are many such stratified developments in Kuala Lumpur, with buildings and roads on the surface and mass transport systems above and under the ground (see the examples in *Fig. 22*). Act 318 has a very strict definition of a building capable of being subdivided. Section 6(1) (Act 318) stipulates that building or buildings must be held as one lot under final title and Section 9 (Act 318)[20] specified that building or buildings must be wholly within the boundaries of the lot in question. This implies that there could be no development for land held under QT (even though the boundaries can be properly defined) and cross boundary development is also not allowed.

The existing laws are also quite incapable of addressing the legal issues and complications faced by the new concept in Malaysian housing development, in particularly by the Gated communities (GC) schemes. Neither the landed property approach (based on NLC) nor strata approach (based on STA) are able to comply with the current regulatory measures.

GC has a few definitions. In the Malaysia context, GC may refers as cluster of houses or buildings that are surrounded by a wall or fence or a perimeter with entry or access of houses or buildings controlled by certain measures or restrictions such as guards, ropes, strings, boom gates, chains or blocks which normally includes 24-hour security, guard patrols, central monitoring systems and closed circuit televisions (CCTV) [*4*]. Currently there are no laws in Malaysia governing the development of land under this concept. Common properties such as public amenities within the

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STA: s. 6(1): Any building or buildings having two or more storeys on alienated land held as one lot under final title (whether Registry or Land Office title) shall be capable of being subdivided into parcels; and any building or buildings having only one storey on the same land shall also be capable of being subdivided into parcels to be held under strata titles or into accessory parcels
STA: s. 9(1)(a)(i): that the building or buildings are situated wholly within the boundaries of the lot in question.

gated community could not be registered (there is no provision for common property under NLC, yet Act 318 allow this under Management Corporation, not the management company appointed by the developer in this case). Buildings such as bungalows, semi-detached houses, double or single storey houses do not fall within the jurisdiction of Act 318, thus could not be subdivided into building parcels (STA: s.6(1) caters for subdivision of building vertically, not horizontally).

3.5 Current Status

With coming into force of the Computerized Land Registration System (NLC: s.5A), the federal government had allocated RM 200 million to implement the National Computerised Land Registration System throughout the country since September 2003. In conjunction with JUPEM existing SPDK, cadastral recording is now fully computerised.

The following tabulation shows the current status of coverage of SPTB and DCDB within the federation.

Table 5: Coverage of SPTB and DCDB [*22*].

	State / Federal Territory (FT)	SPTB			DCDB			
		Lot under Final Title (nos)	Lot in SPTB (nos)	Conversion (%)	Surveyed Lot (nos)	Lot in GLMS (nose)	Lot in DCDB (nos)	Conversion (%)
		A	*B*	*C=B/A*	*D*	*E*	*F*	*G=(E+F)/D*
1	**FT Kuala Lumpur**	150,000	*NA*	*NA*	148,380	*NA*	146,602	98.8 %
2	**FT Labuan**	*NA*	*NA*	*NA*	12,605	*NA*	12,605	100 %
3	**FT Putrajaya**	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
4	**Johor**	750,000	*NA*	*NA*	911,763	*NA*	901,687	98.9 %
5	**Kedah**	482,143	*NA*	*NA*	553,048	*NA*	541,485	97.9 %
6	**Kelantan**	490,000	*NA*	*NA*	680,370	*NA*	679,870	99.9 %
7	**Melaka**	176,621	*NA*	*NA*	234,465	*NA*	234,465	100 %
8	**Negeri Sembilan**	230,000	*NA*	*NA*	439,174	*NA*	437,443	99.6 %
9	**Pahang**	263,000	*NA*	*NA*	433,256	*NA*	429,589	99.2 %
10	**Perak**	593,000	*NA*	*NA*	760,431	*NA*	759,977	99.9 %
11	**Perlis**	60,000	*NA*	*NA*	66,178	*NA*	66,178	100 %
12	**Pulau Pinang**	160,637	*NA*	*NA*	250,901	*NA*	249,552	99.5 %
13	**Sabah**	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
14	**Sarawak**	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
15	**Selangor**	529,460	*NA*	*NA*	827,615	*NA*	813,843	98.3 %
16	**Terengganu**	295,200	*NA*	*NA*	430,002	*NA*	427,757	99.5 %
	TOTAL:	**4,180,061**			**5,748,188**		**5,701,053**	
	COVERAGE:			*NA*				**99.2 %**

Note:
1. NA- Information not available.
2. Statistics for SPTB (as per early 2006 from NRE) and statistics for DCDB (as per end of 2004) were all based on [*22*].

However, there is nothing much to analyse as *Table 5* contains few details. Both the JKPTG (Bahagian Kemajuan Pengurusan dan Perundangan, Seksyen Komputer Pentadbiran Tanah or Computerised Land Administration Section of the Management Development and Legal Division) and JUPEM are reluctant to release the relevant statistics, although JUPEM [*15, viewed June 21st, 2006*] claimed to have a total of 6.4 million cadastral lots and 450,000 CPs nationwide.

Nevertheless it is reasonable to believe that there are patches of irregularities as both systems operate separately, and JUPEM do not always receive all the relevant information from land office, especially for areas under new alienation, subdivision and land under QT. The above disparities shall constitute a good basis why there is a need for integration (see §5.3.2).

3.5.1 SWOT analysis of current cadastre

SWOT Analysis is a tool used for understanding an organisation's strengths, weaknesses, opportunities and threats. It can also be used for a system such as Malaysia Cadastre, to identify its inherent strengths (S) and weaknesses (W), then to examine the opportunities (O) and also the possible threats (T). This analysis shall focus on two aspects, namely cadastral survey and title registration (partly compiled from [*45*]):

Strengths (S)	Weaknesses (W)
Cadastral Survey: • Surveyed lots are stored digitally within the DCDB; each state with its own DCDB • Scanned images of CP are maintained within a digital library • Supplementary information for demarcated or lot under 3rd class surveyed, QT, administrative area boundaries, building outlines and some non-spatial attributes have been captured via GLMS, another database within the upgraded SPDK • SPDK has four subsystems – SPEK (DCDB), SPID (CP imagery), counter service and e-commerce to access and carry out online transaction • Under one single government organization (JUPEM) at both state and federal level	Cadastral Survey: • Non-homogeneous coordinate system among states, resulting in standalone DCDB • Incomplete database due to late transmission of RS (see §3.4.1) from Land Office, delay in CP submission from both the government and private licensed surveyors, CP with insufficient information on edge of river or road and attributes names • Some topographical details have been extracted from outdated maps • Information for demarcated lot under 3rd class survey, QT, administrative area boundaries, building outlines and some non-spatial attributes are keep in GLMS, outside DCDB • No information about non-alienation aspect of disposal of land, such as TOL (see §3.4.2), permit to use air space, permit for removal of rock material, reserved land (some allocated no lot number) • No information on lots partly or wholly defined by natural boundaries • Not all administrative area boundaries have been digitised, that include district, mukim and local government, and reserved land (forest reserve, open space) • Absence of metadata on quality, accuracy or currency • DCDB is basically 2D in nature, although the

	vertical dimensions are available in field records and certified plans (strata and stratum).
Strengths (S)	**Weaknesses (W)**
Title Registration: • Title information can be accessed via computer terminals at the respective state registry office as well as every district land offices through SPTB • National Land Council to promote coordination among federal and states, to ensure a unified land legislation (NLC, Act 318 etc.) with standardised rules and regulations (JKPTG circulars) • SPTB (if integrated with DCDB) facilitates various planning, e.g. the town and country planning, privatisation, planning for land acquisition for public purposes, infrastructure and replanting of agriculture crops • Provides the base for macro and micro analysis in land use to promote sustainable development	Title Registration: • One SPTB for each state, all are standalone • Parcel data consistency is in doubt as there is no mechanism to integrate with JUPEM's DCDB • All dealing shall be conducted only at each respective state registry or district land office, depending at where the title was formerly registered • No internet access of information is available, only intranet access at registry or land office terminal or via dedicated data line linking land office with specific users • Lack of coordination at federal / state level, National Land Council's perspectives do not always reflects states' aspirations • Absence of standardised procedures, each state has its own state land rules

Opportunities (O)	Threat (T)
Cadastral Survey & Title Registration: • The standalone databases have limited applications beyond their normal scope of functions. But if both can be properly integrated to form a comprehensive land information system at district and state level, even at national level, then the potentials could be tremendous • There are initiatives working towards a national unified coordinate system for both the cadastral and topographic surveying. Height information and topographic details can be easily integrated with DCDB to provide the required 3rd dimension for 3D cadastre (see also §5.3.2)	Cadastral Survey & Title Registration: • All data are proprietary, even among the various departments within the same state government • One database is organised by a federal agency while the other a state set up, there is no mechanism for reconciliation, updating and sharing of data • Data maintenance and constant updating is a continuous process to ensure information is correct and up to date • Close to 3 million outstanding cases of QT (2002 figures) yet to be resolved • Haphazard system implementation without taking into account of the requirements and compatibility of prospective sharing departments / agencies. The sourcing for hardware, software and training of required human resources are all done independently • Breach of security should be guarded at all means, to avoid previous frauds whereby dealings were being registered without the knowledge of the registered proprietor from recurring (*Item 2.4, Joint Memorandum to National Economic Action Council, Aug 15th, 2005* [*40*]) • Inappropriate land use and development regulations hamper healthy growth of land market; NLC and STA with inadequate provisions for registration of stratified development across boundary and development under modular concept, where subdivision involves 'land', not 'building' • Guidelines proposed at federal level are not always adopted at state level; there is no legal method of enforcing its mandatory compliant

4. CURRENT PRACTICE OF 3D REGISTRATION

Traditional cadastre is based on division of land into 2D parcels. Ownership rights are registered on these surface parcels. However, rights of use and interests in land have also a vertical spatial component in height and depth. Most 2D registrations are found to be adequate as long as the whole column of space belongs to a person or a ground of persons.

However, the legal situations in cases of multiple use of space, where the same parcel of land is held simultaneously by several persons, either as owner(s) or rights or interests holders could not be portrayed effectively on flat surfaces (see §2.3.2).

This chapter researches on the current practice of 3D cadastral registration in several countries – the Netherlands, Israel, Norway and Australia. The knowledge gained from these case studies shall be the foundation to formulate a feasible Malaysian 3D cadastre. Each case study begins by a brief introduction about the country in general, then to study its cadastral system before continues to investigate the adopted solutions for 3D registrations and finally looks into their strengths and weaknesses.

4.1 Dutch Cadastre

4.1.1 Country background information

Location	Western Europe, bordering North Sea, Belgium and Germany.
Area	*Land*: 33,883 sq km *Water*: 7,643 sq km ***Total***: 41,526 sq km.
Climate	Temperate.
Population	16.49 million (July 2006 estimate).
Government type	Constitutional monarchy.
Administrative divisions	12 provinces: Drenthe, Flevoland, Friesland, Gelderland, Groningen, Limburg, Noord-Brabant, Noord-Holland, Overijssel, Utrecht, Zeeland and Zuid-Holland.
Legal system	Civil law system.

(source: The World Factbook [*8*])

Fig. 24: Map of the Netherlands [*ibid*].

4.1.2 Country cadastral system

Cadastral survey and land registration are by the state jurisdiction assigned by mandate (Civil Code and Cadastre Organisation Act) to Kadaster. The Kadaster (Dutch Land Registry Office) is responsible for the registration of parcel boundaries (cadastral map) and its legal status (land registry) in the Netherlands. Kadaster [*16*] listed its functions as:

> *Collect information about registered properties in the Netherlands, record them in public registers and in cadastral maps and makes this information available to the members of the public, companies and other interested parties in the society*.

Kadaster collects details of goods in the Netherlands subject to compulsory registration, stores these in public databases and cadastral maps and makes these available, for a fee, to companies, private individuals and other interested parties [*ibid*].

The current practice of cadastral registration by Kadaster consists of:

- Spatial LKI (Landmeetkundig Kartografisch Informatiesysteem or Information System for Surveying and Mapping), the 2D geo-DBMS for maintaining the geometry and topology of parcels
- Administrative AKR (Automatisering Kadastrale Registratie or Automated Cadastral Registration), the DBMS for maintaining legal and other administrative data

and

- Public Register (Openbare registers), a registration of mainly notarial deeds archived chronologically

A unique parcel ID provides the required linkage between these DBMSs. LKI stores the large-scale topographic and cadastral data (geometric database) in an Ingres database using OME/SOL (Object Management Extension/Spatial Object Library). Legal and other administrative data related to the parcel (administrative database) are maintained in an IDMS (Integrated Database Management System) database on IBM mainframe.

These two databases are loaded monthly into a single Ingres DBMS, to provide an environment for the easy access to all data for analysis, query and filter. A generic query tool has been incorporated for analysis and performing consistency checks on the cadastral source data to improve its quality.

There are previously three basic types of objects, namely ground parcel, part parcel and apartment. However, the recent Dutch Supreme Court ruling (Hoge Raad, 06/06/2003: 36075; kabel is onroerende zaak) reinforced the need to register cable and pipeline as the 4th registrable object.

Fig. 25: The subdivision of part parcels from ground parcel, the formation of apartment complex from parcels and subsequently to individual apartments [*55*].

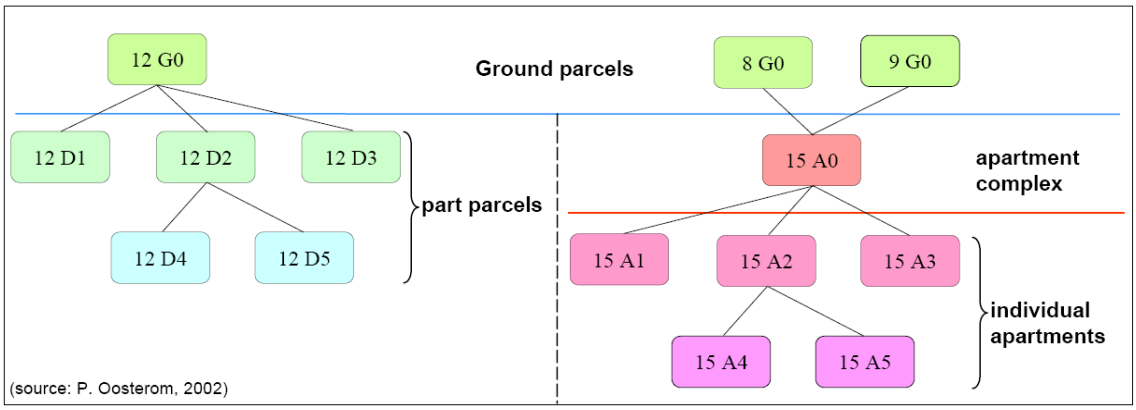


Fig. 26: Dutch CCDM with four registrable objects and a unique parcel identifier to link the geo-DBMS and the administrative data [*9*].

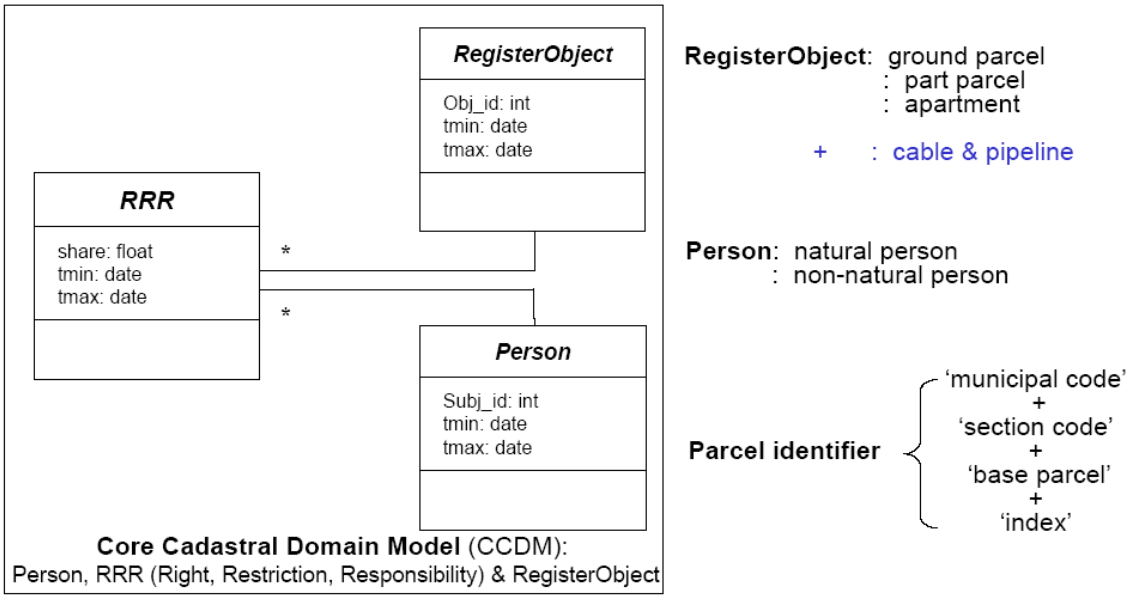
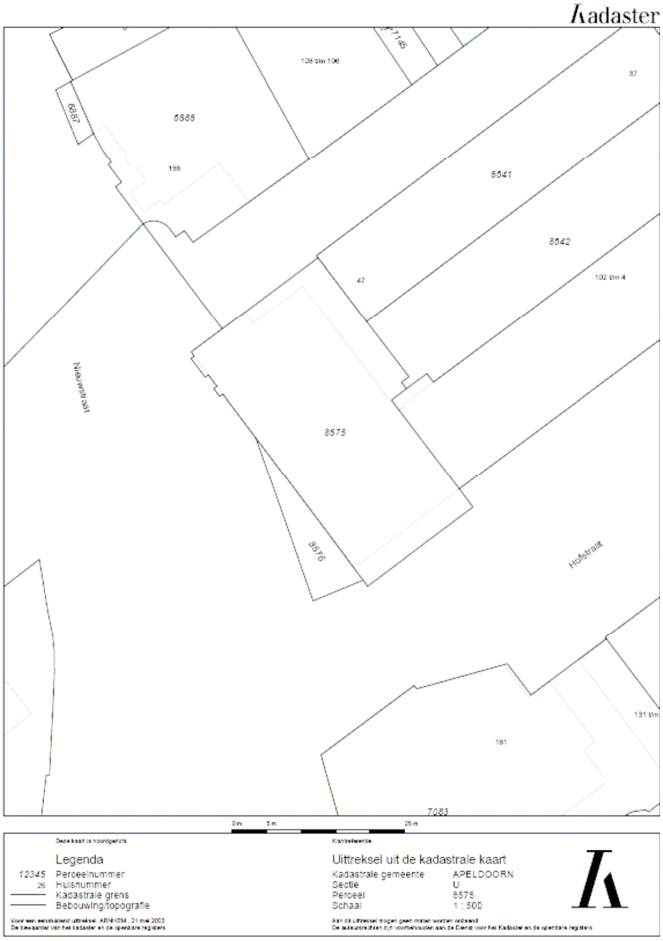


Fig. 27: Dutch cadastral map [*10*].



4.1.3 3D registration

Dutch registration of stratified property has the following characteristics:

- Right of use space in the vertical dimension has not been explicitly defined. Dutch Civil Code: Book 5, article 20 and 21 defined right of use space as "*space above or under the surface to an extent sufficient for its reasonably use, subject to other law and regulations (e.g. Law on Air Traffic and Law on Mining)*"
- Cross boundary construction is allowed, provided with permission from the relevant parcel owner
- Other than the vertical division into apartment (itself is a registrable object), there is no formal rules for registering either the legal status or the spatial extent of 3D property situation
- Various administrative solutions have been employed to reduce the 3D situations as projection onto the existing surface parcels, while the legal status of the property divided horizontally is being established by registering as rights and limited rights on these parcels (still contains no explicit height values)

- Stoter [*47*] listed the following means to register the legal status of stratified property:
  - *registrable private law* – e.g. full ownership (eigendomsrecht or right of property), encumbered (restricted) property rights (privaatrechtelijke beperkingen), which include superficies (opstalrecht)[21], emphyteusis (erfpacht) and easement (erfdienstbaarheid), apartment right (appartementsrecht) and joint ownership (mandeligheid)
  - *non - registrable private law* – e.g. horizontal accession (horizontale natrekking)
  - *non - registered toleration* – e.g. laying cable and pipe on government land
  - *restrictions imposed by administrative law* (publiekrechtelijke beperkingen) – e.g. obligation to allow constructions for public good (belemmeringenwet privaatrecht such as the utility cable and pipeline), exclude from right of minerals extraction (mijnwet) and registration of severe soil pollution (wet bodembescheming)

- These ad-hoc solutions are best illustrated via the following examples:

Fig. 28: Apartment rights[22] [*ibid*].

Horizontal accession to real property, the portion of grey building encroached into parcel 1 is owned by the landowner of parcel 2.

One ground parcel jointly owned by three apartment owners, via deed of division (splitsingsakte).

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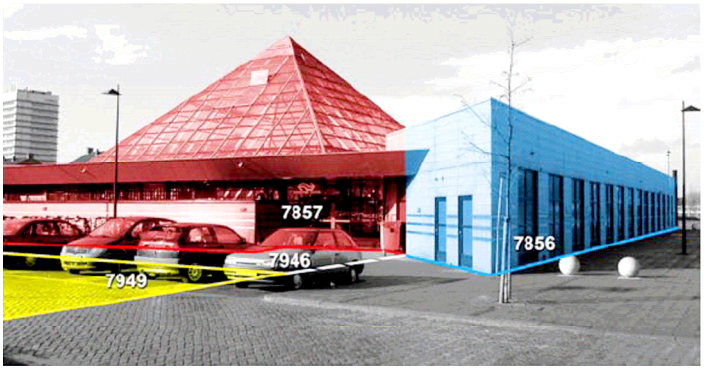
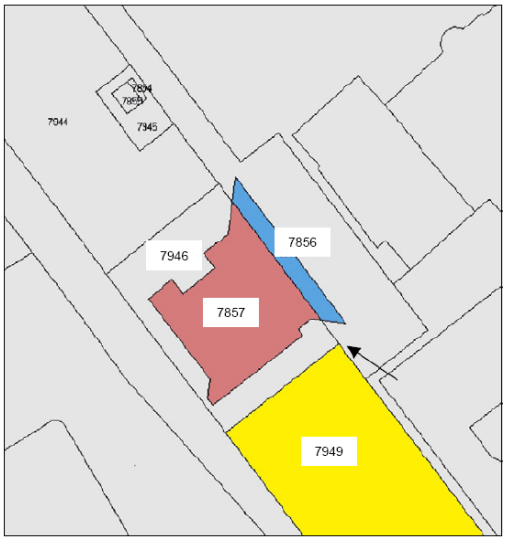
Encumbrance: An impediment to the use or transfer of the property in the form of an interest or right in the property, e.g. easement, mortgage or caveat, (www.aaamortgagesolutions.com.au).
Superficies: right to use the land of another person with the objective of owning thereon a structure, other work or trees. It is a right over things existing on the land owned by another person for the purpose of using such land.
Easement: rights exercisable by owners of one parcel of land over other land.
Emphyteusis: the holding of temporary or perpetual rights.

22

Dutch Civil Code: Book 5, article 106 defines apartment rights as a right to exclusive use of certain part of the building and may also includes to certain parts of the land where the building is erected. These rights are created by means of a notarial deed (splitsingsakte or deed of division), accompanied by a scanned or analogue drawing showing the overview of the building and detailed floor plans. Deed and drawing are registered in the public register.

Fig. 29: Rijswijk Railway Station [*49*].





Rijswijk railway station (parcel 7856 & 7857) was built on top of underground railway tunnel. Fragmented parcels based on 3D objects were projected on the surface to enable the following 3D registration:

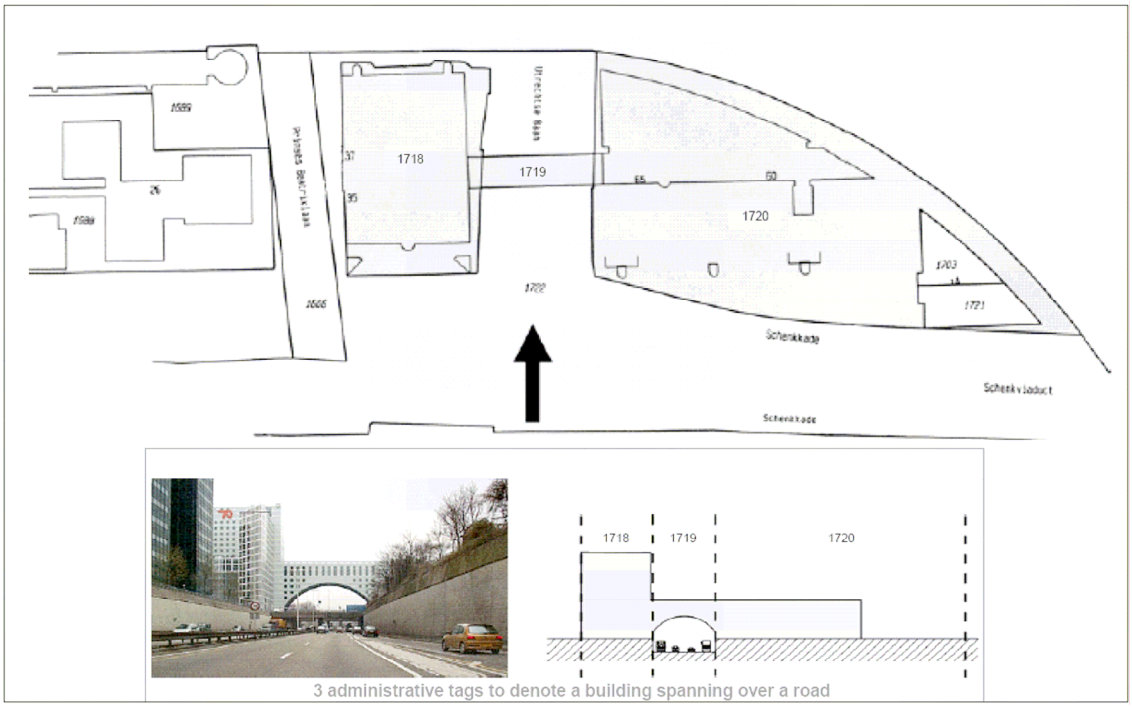
Land ownership

- Parcel 7856 - full ownership (blue building included) to NS Vastgoed BV
- Parcel 7857 - encumbered ownership (less red building) to NS Railinfratrust BV
- Parcel 7946 - full ownership to NS Railinfratrust BV
- Parcel 7949 - encumbered ownership (less yellow surface construction) to NS Railinfratrust BV

Spatial construction ownership

- Blue building (7856) - NS Vastgoed BV
- Red building (7857) - right of superficies to NS Vastgoed BV
- Yellow surface construction (7849) - right of superficies to Rijswijk Municipality

Fig. 30: Nationale Nederlanden's building [*47*].



Nationale Nederlanden's building spanning across the road is divided into three parts in order to register its legal status (one building, 3 parcels):

Land ownership

- Parcel 1718 - full ownership to Nationale Nederlanden
- Parcel 1719 & 1720 - encumbered ownership (less grey portion of building) to Den Haag Municipality

Spatial construction ownership

- Grey building (1718) - Nationale Nederlanden
- Grey building (1719) - right of superficies to Nationale Nederlanden
- Grey building (1720) - right of emphyteusis to Nationale Nederlanden

Fig. 31: Cable and pipeline [*49*].

Telecom cable is being registered as one object with reference to the anchor parcel, while pipeline is registered into the administrative AKR database either as opstalrecht[23] or via the various forms of legal notification, with reference to the associated ground parcels. Each of these objects shall be assigned a unique object ID in the future:

Land ownership

- Encumbered ownership (less construction) to original land owners

Spatial construction ownership

- Right of superficies to utility operator

23
Opstalrecht represents the rights to erect buildings, under, on or above land owned by a third party, while legal notification is merely a legal indication that the said land is subjected to restriction.

4.1.4 Strengths and weaknesses of 3D representation

Strengths (S)	Weaknesses (W)
• Employed existing land legislation to register the various stratified properties • Horizontal division in the legal status of property is by means of registering rights and encumbered rights on ground parcel • Insight into the 3D situations is available as analogue drawing attached to the notarial deeds (attachment of drawing non-mandatory other than the case of apartment) • Provides creation of part parcel (deelperceel) prior to formal subdivision • Below surface constructions can be shown as stripe-line on cadastral map as an indication of underground construction, merely for the purpose of orientation and not for registration • Kadaster has developed a query tool to visualise rights and restrictions on parcels by linking the graphic (LKI) and administrative (AKR) database	• Only ground parcels are maintained within the cadastral map • Indirect registration via ground parcel means neither the right itself nor the object of the right is explicitly registered • Accessibility of the registration in 3D situations is not optimal without digital 3D representation (only analogue drawing attached to the deeds) • Different ad hoc solutions even with comparable 3D situations • No analysis is possible as neither the physical object nor its characteristics are stored within the database • Constructions are illogically subdivided to match that of the ground parcel • Data redundancy as every intersected (with the construction) parcels need to be registered repeatedly even though the object (construction) is the same • Data integrity hard to maintain, especially when the associated parcels get further subdivided (can only identify the parcels, but the exact location of stratified property is not known)

4.2 Israel Cadastre

4.2.1 Country background information

Location	Middle East, bordering Mediterranean Sea, Egypt and Lebanon.
Area	*Land*: 20,330 sq km *Water*: 440 sq km ***Total***: 20,770 sq km.
Climate	Temperate.
Population	6.35 million.
Government type	Parliamentary democracy.
Administrative divisions	6 districts: Central, Haifa, Jerusalem, Northern, Southern and Tel Aviv.
Legal system	Mixture of English common law, British mandate regulations, and in personal matters, Jewish, Christian and Muslim legal systems.

(source: The World Factbook [*8*])

Fig. 32: Map of Israel [*ibid*].

4.2.2 Country cadastral system

Israel land regime is very unique, the government owns about 93% of the land. These lands are then leased to the public in various forms as short or long-term lease. Land administration is responsible for the administration of these leases and marketing of land for further development.

The Survey of Israel is the government agency in charge of cadastral survey and mapping, while title registration is by the Land Registration Office. Israel cadastre is based on Torrens system where the state guarantees the boundary and area of 2D parcels. Intensive use of land in the central and northern regions resulted in many stratified development. Previous registration by easement for the benefit of the state was found to be inadequate, as legal information usually lacks the accurate and real (as-built) details.

3D registration is being introduced for "*facilitating more efficient land use, including subterranean space, and integrating several infrastructures and various applications in a single locality*" [*21*].

4.2.3 3D registration

Israel 3D Cadastre has the following characteristics:

- Definition of surface parcel remains unchanged and title rights to the surface parcel preserved ("*ad coelum*" doctrine)
- Subdivides the surface space into spatial sub-parcels (spatial parcels), defined as volume object
- Project with spatial sub-parcel (above or below surface) shall be bounded and defined stereometrically by a 3D outline and its volume
- There is no infringement to rights of land, except for proper purposes and limited to minimal required extent
- A cross boundary spatial project shall be subdivided into spatial sub-parcels in according to existing surface parcels
- Sub-parcels within a registration block can be consolidated into one spatial parcel
- Stability of existing surface structures shall be safeguard by providing sufficient clearance from the sub-parcel, basing on engineering considerations
- Allows extension and adaptation from the existing registration system by amending the Land Law, Planning and Construction Law, also the Survey Ordinance
- A memorial (notice) will be registered while the project is under planning and construction, the final registration of subterranean sub-parcels take effect only after the completion of project, based on as-built
- Maps and plans are in the form of digital database, vector, GIS or digital map, and the 3D spatial representation can be visualising from various perspectives and sections

Fig. 33: Subdivision of surface parcel into spatial sub-parcels [*44*].

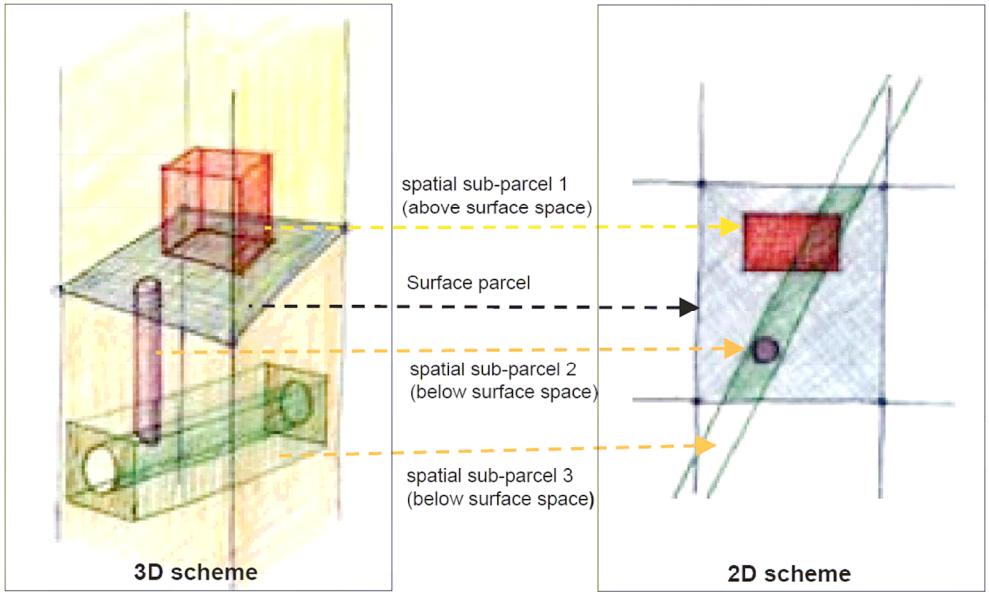
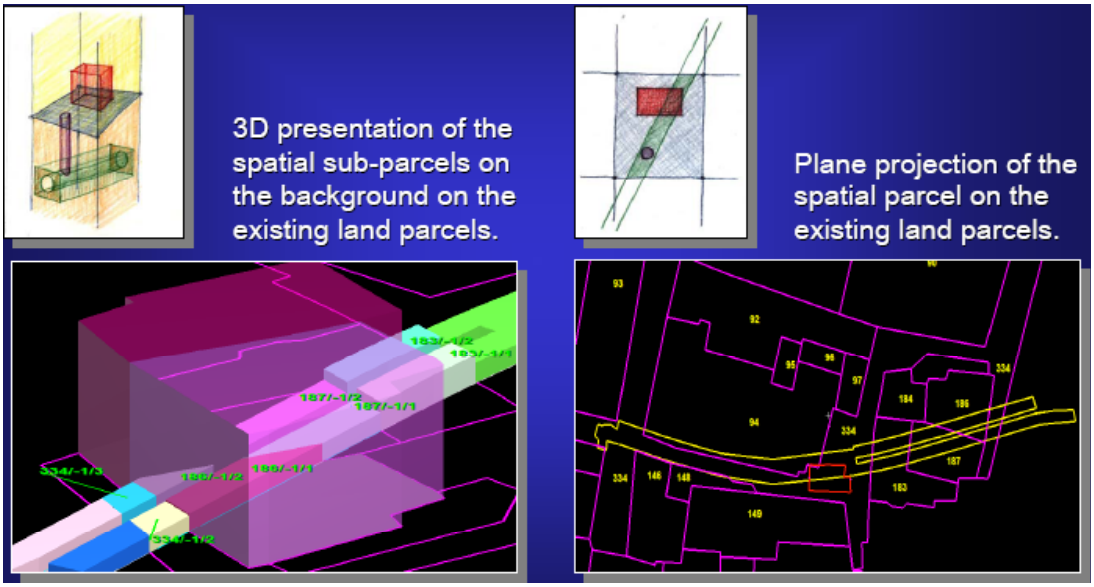


Fig. 34: The principles of Israel 3D cadastre [*ibid*].



4.2.4 Strengths and weaknesses of 3D representation

Strengths (S)	Weaknesses (W)
• Existing registration method is preserved, with parcels defined on the surface remain as the opening for registering spatial objects • Title rights to the surface parcel are preserved (extending infinitely above and below the surface), less the volume object defining the spatial sub-parcel • The expropriation of specific parts of the space defined within the vertical column of surface parcel in the form of spatial sub-parcels made possible the registration of spatial objects in the above surface and below surface space • Spatial sub-parcels for a spatial object within a registration block can be further consolidated into one spatial object if necessary • Provides the visualisation of 3D cadastral mapping as perspective presentation (various views from different angles)	• Spatial object is illogically subdivided to spatial sub-parcels to match that of the surface parcels • Israel Evidence Law does not recognise digital document without the original hardcopy as conclusive evidence

4.3 Norwegian Cadastre

4.3.1 Country background information

Location	Northern Europe, bordering North Sea and North Atlantic Ocean.
Area	*Land*: 307,860 sq km *Water*: 16,360 sq km ***Total***: 324,220 sq km.
Climate	Temperate.
Population	4.61 million (July 2006 estimate).
Government type	Constitutional monarchy.
Administrative divisions	19 counties: Akershus, Aust-Agder, Buskerud, Finnmark, Hedmark, Hordaland, More og Romsdal, Nordland, Nord-Trondelag, Oppland, Oslo, Ostfold, Rogaland, Sogn og Fjordane, Sor-Trondelag, Telemark, Troms, Vest-Agder, Vestfold.
Legal system	Mixture of customary law, civil law system and common law traditions.

(source: The World Factbook [8])

Fig. 35: Map of Norway [*ibid*].

4.3.2 Country cadastral system

Norwegian Mapping and Cadastral Authority (NMCA) is the national supplier and manager of land, property and geographic information. The Department of Cadastre and Land Registry was established in 2003 when NMCA took over land registration from the courts. This department operates the central cadastre database (Central Cadastre register, the register for properties, address, buildings and apartments) and supervises 434 municipalities that are doing cadastral survey and data entry. It also maintains a central land registration office by taking over land register functions from 87 courts.

The property register in Norway is called the GAB. It is a uniform system of property identification based on the now defunct Land Book (the G or ground property register, the A or Address Register and the B for new buildings under construction or Building Register). GAB is only a textual database with no connection to topographic or cadastral map. The duties for cadastral survey and mapping are assigned to the municipalities. Currently the national digital cadastral map (DEK) is being developed jointly by NMCA (for rural areas based on economic maps) and municipalities (for urban areas based on cadastral survey maps).

Both cadastral map and land registry are being computerised since the 80s but the digital cadastral maps are still under establishment (maps not complete and not accurate beyond city limits). Data from both registers are being combined and can be accessed through an integrated online service covering the whole country (there are 30,000 terminals operated by the state owned Norway Land Information Ltd.).

A new Law on the Cadastre was being introduced and is expected to come into force on Jan 1st, 2007. The main components of this legislation are:

- Private surveyors are also allowed to carry out cadastral surveys
- A national cadastre ('matrikkelen') with both land registration and the corresponding digital cadastral map will be made available in 2007
- Legal basis for registration of 2 new types of cadastral units, property in strata (building / construction divided horizontally from one or several property units) and joint property (land jointly owned by property units, e.g. forests, mountains, pastures, lakes etc owned jointly by property units)[24]

4.3.3 3D Registration

A national cadastre with both land registration and the corresponding digital cadastral map will be made available in 2007. The new Law on the Cadastre also includes for the first time regulations for establishing and registering properties below and above the surface. Underground parking garages and buildings or constructions on pillars above the surface can be registered as separate properties. For apartments, individual ownership could be established using either the existing Sectioning Act or Subdivision Act, whichever is convenient. Such sectioning approach might not be optimal, but the process is considered fairly cheap and simple to execute.

The proposed Norwegian 3D Cadastre has the following characteristics:

- Intended for 3 types of 3D property – underground constructions (garages, shopping areas, storage halls, tunnels etc), buildings/constructions erected on pillars or other means, above the surface of earth (buildings on top of roads, railways etc.) and constructions on pillars at sea or in fresh water
- 3D property could be registered without subdivision on the surface property (e.g. occupation of "*no man's land*" below the surface property and construction on seabed (seabed has no surface parcel to subdivide from))
- Option to introduce strata titles based on use rights related to surface property, rather than formal subdivision from the surface property
- The concept of "*construction property*" was being proposed to avoid land speculation, i.e. 3D property is approved only when it is needed to support a particular approved construction
- 3D property cannot be established for parts of building or for building erected directly on the ground as it can be more appropriately established as condominium (ownership of flat or 'section' is governed under the condominium law)
- Norway establishes no finite depth of ownership, the accepted depth is as far as you are able to utilise it. A restrictive clause will be added to the title deed to facilitate settlement of survey for underground construction

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The existing cadastral units are: **property unit** – ordinary cadastral unit comprises one or several parcels, with boundaries delimited by property boundaries on the surface and extend of ownership space based on "ad coelum" doctrine, **leasehold unit** – part of property unit leased for building purposes, **section** (of building / condominium) – part of built-on property or leasehold with exclusive rights to dispose one or several apartments / premises of the property [*32*].

Fig. 36: The concept of "*construction parcel*" without reference to the surface parcel, but limits only to underground construction, construction or building erected on pillars above the surface of earth or on pillars at sea or in fresh water [*54*].

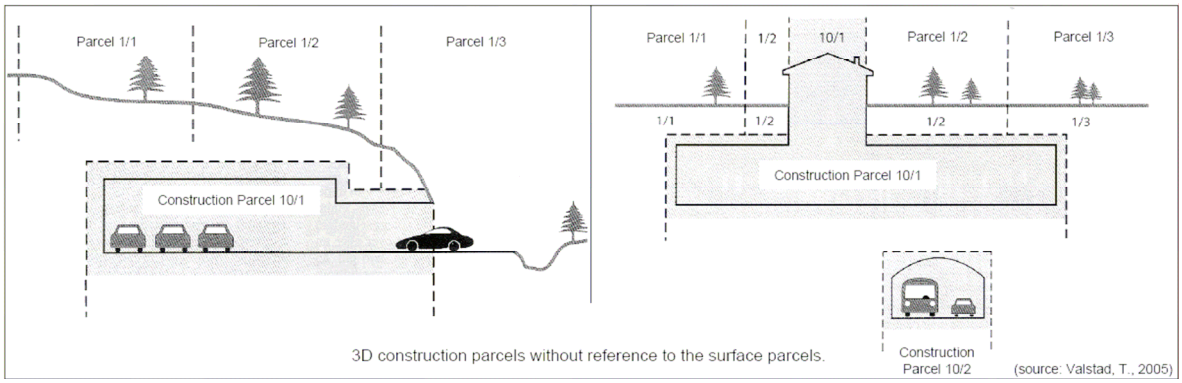


Fig. 37: Right - housing complex with underground parking, the cadastral map with underground parcels in black and surface parcels in red.
Left - the survey certificate for the complex parcel with various top levels but only one bottom level. Coordinates for each corner are provided [*ibid*].

4.3.4 Strengths and weaknesses of 3D representation

Strengths (S)	Weaknesses (W)
• Surface property remains as the primary property object • Registration of 3D property without subdivision from the surface parcel • 3D properties can also be established at sea or in fresh water areas • 3D property can only be established when it is needed for an approved construction (hence the concept of construction parcel). This is a preventive measure against land speculation	• Unregulated creation and registration of stratified property • The concept of construction parcel is applicable to only three types of 3D properties (see §4.3.3) • The registration of 3D property is not mandatory, take for example underground constructions may be registered as servitude on surface parcel, or remain unregistered in the cadastre • The precision required for the documentation of the physical location of the 3D property is leave to the discretion of parties involved

4.4 Australian Cadastre

4.4.1 Country background information

Location	Oceania, world largest island continent between Indian Ocean and South Pacific Ocean.
Area	*Land*: 7,617,930 sq km *Water*: 68,920 sq km ***Total***: 7,686,850 sq km.
Climate	Temperate in south and east, tropical in north.
Population	20.26 million (July 2006 estimate).
Government type	Democratic, federal-state system with British monarch as sovereign.
Administrative divisions	6 states and 2 territories: New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia, Australian Capital Territory and Northern Territory.
Legal system	Based on English common law.

(source: The World Factbook [8])

Fig. 38: Map of Australia [*ibid*].

4.4.2 Country cadastral system

Land administration in Australia is under state jurisdiction and spreads over a range of government departments such as Environment, Planning, Information Technology or Land Administration. The cadastral database (state digital cadastral map included) is administered by the Land Registry and Titles Office, Crown Lands Management Office, Surveyors Boards and business units for Land Information and Resources, integrated through sharing agreements at one central metropolitan office. A consortium of all states, the Public Sector Mapping Agency Ltd. is responsible for the production of national maps.

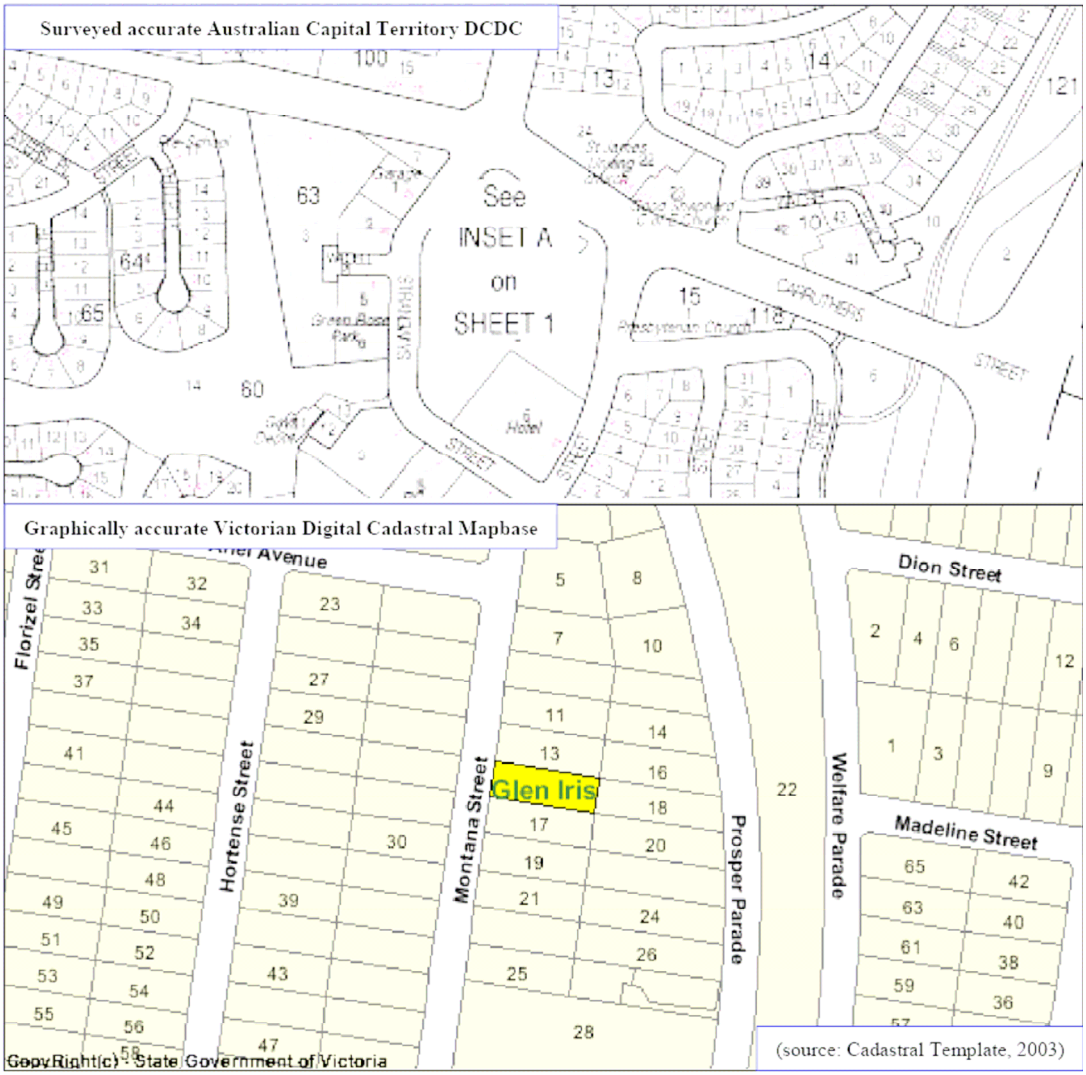
Cadastral systems are not consistent across the 8 jurisdictions. There are eight variations of the Torrens system, each differ slightly in the titling and registration. Cadastral survey is governed under the Survey Acts and Regulations in each jurisdiction while title registration is at the Land Registry.

The typical components of Australia cadastre are:

- Spatial component – the graphic representation of parcel (or DCDB) with corresponding plan numbers and unique parcel identifier
- Textual component - land register that identifies the land parcel, ownership, owner's rights (also restrictions and responsibilities) and dealings (easement, mortgage etc.)
- Administrative component – additional legal, valuation, local government, utilities and planning information
- Crown Lands Management – management and administrative records for state owned land

The integrity of DCDB is supported by survey plan and field notes with legal measurement in a digital parcel-based dataset. Cadastral information from both DCDB and computerised land register is updated daily, and is accessible via internet for a fee. A national cadastral database (Cadastral Lite) has been integrated based on a common GDA94 coordinate datum.

Fig. 39: Examples of Australian cadastral map [*10*].



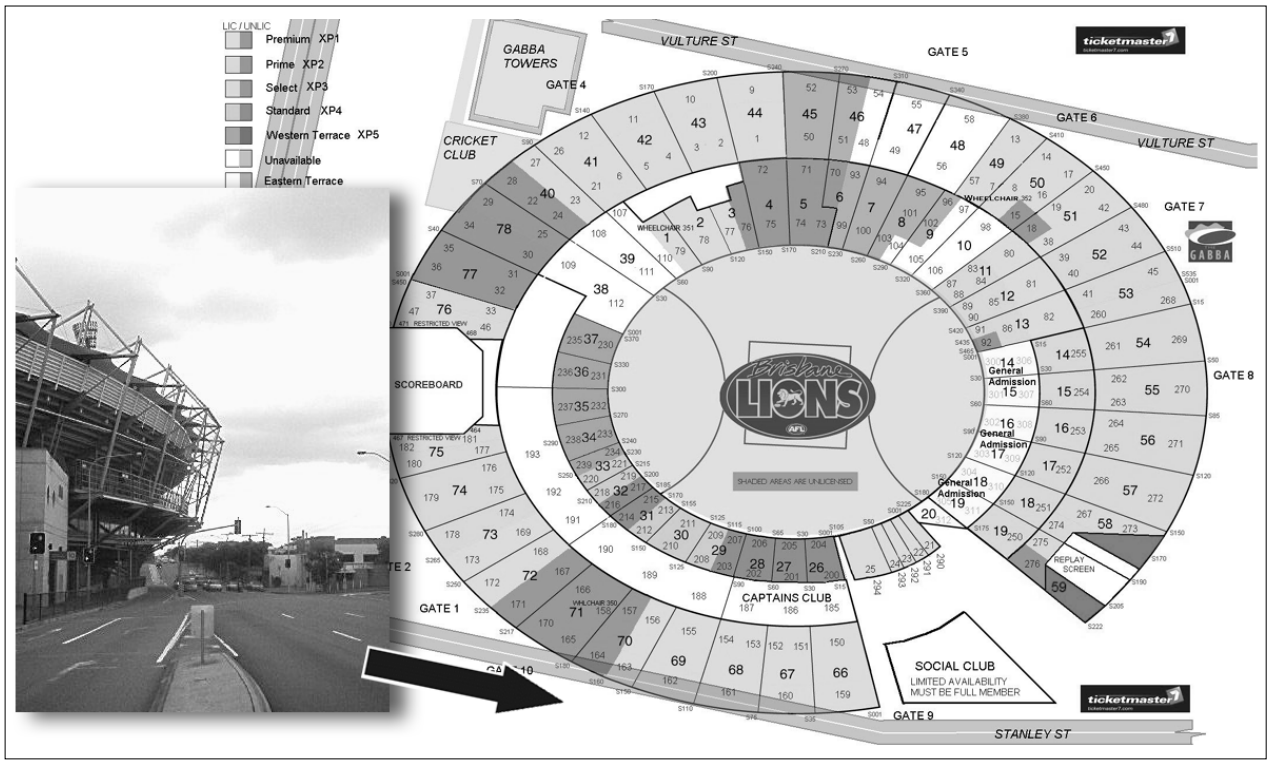
4.4.3 3D registration

The current practice of 3D registration in Queensland [*51*] is being examined here, with the following characteristics:

- Land Title Act, 2003 of Queensland provides for 5 types of registrable parcel:
  - standard parcel - defined in 2D but implying whole parcel column
  - building parcel - defined by floors, walls and ceilings
  - restricted parcel - restricted in height or depth, with boundaries coincide with boundaries of the surface parcel
  - volumetric parcel - fully defined by bounding surfaces and independent to surface parcels
  - remainder parcel - normal standard parcel less the volumetric or building parcel
- The height values of restricted parcels are indicated as relative to the surface or by a defined plane

- The vertical restrictions on easements are based on Australian Height Datum and tied to permanent marks
- A volumetric parcel is registrable as long as its surfaces are mathematically definable (using 3D points to identify its position, shape and dimensions of each bounding surface). The height values are based on Australian Height Datum and the corners of volumetric parcel should refer to existing structures or marks as much as possible. These 3D descriptions are stored in title registration and a footprint[25] of the volumetric parcel is indicated on the cadastral map
- The DCDB of Queensland consists of parcels, road, rail, watercourse and intersection parcels (part of roadway, being the intersection of two roads, railway or water) without any overlap. Building and volumetric parcels are not part of this non-overlapping coverage, but the footprints of the volumetric parcels are indicated.

Fig. 40: Overview of Gabba Stadium overhanging Stanley Street (southern Gate 9) and Vulture Street (northern Gate 5), 3D volumetric parcels are established for the portion encroached into the roadway [*51*].



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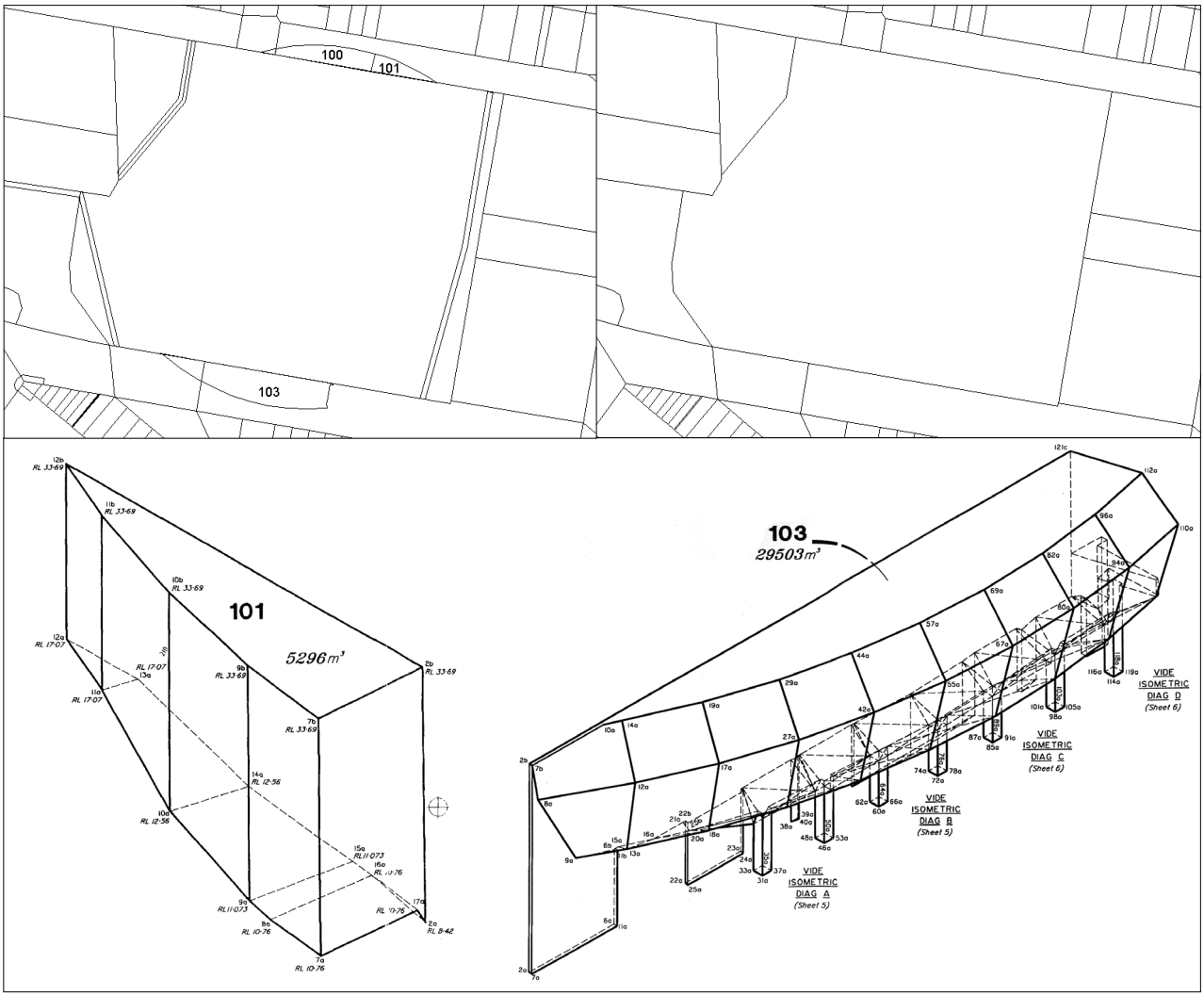
Footprint: the outside dimensions of a building in building measurement, describing the amount of space it occupies on the ground [Glossary, The Urban Land Institute, San Francisco, USA, www.urbanplan.org].

Fig. 41: Cadastral map with and without footprint of the three volumetric parcels (100, 101 & 103) and examples of 3D diagrams showing the volumetric parcel 101 and 103 [*51*].



4.4.4 Strengths and weaknesses of 3D representation

Strengths (S)	Weaknesses (W)
• Existing legislature flexible enough with provision for the establishment of 3D parcels • Volumetric parcels are registrable as long as the surfaces are mathematically definable • 3D descriptions (detailed 3D diagram with various cross-sections) are maintained in title registration, while the footprints of volumetric parcels are indicated on the cadastral map	• 3D property units exist only in the administrative title registration (survey plans with detailed sectional or 3D diagrams are scanned drawings attached to land title), while 3D geometry is not available within DCDB (only as footprint)

The above case studies showed that although the solutions adopted vary among the county, but it is or will be soon possible to establish 3D property units within the existing juridical framework. However, none of these solutions is able to provide a complete solution to 3D cadastral registration. The geometry of the 3D property units is not maintained in a geo-DBMS and neither the object itself nor its characteristics is represented in the geographical database (DCDB).

The experiences gathered from these case studies and the viable solutions shall be adopted for the proposed Malaysian 3D cadastre wherever applicable. This shall be explored in Chapter 5.

5. TOWARDS 3D REGISTRATION IN MALAYSIA

The consensus among many researchers is that future cadastre shall be analytical, three-dimensional, multilayer, and similar to current 2D cadastre (consists of register and map) and will be still concerned with land, law and society. It shall provide proper adjudication of 3D-boundaries in space, serve the legal and physical objectives; yet facilitate basic mapping, planning land use and spatial environmental planning [*6*].

This chapter touches on the approach and selection criteria for an optimal registration solution for multilayer use of space, evaluates from the perspectives of juridical, organisational and technical aspects and finally how best it can be introduced in Malaysia.

5.1 Introduction

Cadastre, being the public register, holds information about land, including tenure, ownership, spatial relationships and interests (rights, responsibilities and restrictions). The land surveyor provides the spatial component of the cadastre. This spatial component includes the physical infrastructure (boundary marks) and records of survey (field records, computation, certified plan and DCDB). It defines the size and extent of a land parcel, its spatial relationship with other parcels, man made infrastructures (roads, railways etc.) as well as the natural features (rivers, ponds etc.). The land title register, is being administered by the state authority, defines the non-spatial aspects of the cadastre. This is being maintained in the register (previously done manually, now taken over by SPTB and maintains as database) and documents of ownership (document of title, permit, gazette plan etc.).

Currently there are provisions to survey and issue title for strata (subdivision of building) and stratum (underground land), but the graphical cadastral map or digital cadastral database (DCDB) is only two-dimensional in nature. It contains neither altimetry information nor detailed information of existing objects or structures within the parcel area. The vertical dimensions are only available on the authenticated strata and stratum certified plans, as scanned images in the image library (SPID, see Appendix B2 and B3). As these 3D objects or structures are kept outside the cadastral database, they can neither be searched nor analysed.

5.2 Examining The Requirements

The Bogor declaration [*53*] stated that there is a vast array of legal, technical, administrative and institutional options available in designing and establishing an appropriate cadastral system. The success of a cadastral system in especially the developing countries depends on an appropriate legal and administrative framework, the complex interrelationship between institutional management issues and lastly the available tools and technology. All of these are interrelated and influencing each other.

5.2.1 Basic requirements

3D representation provides clearer definition of the juridical situation of the property within the multilayer reality as it corresponds to reality better than the traditional 2D presentation. Moreover, ability to display 3D representation allows better tools for examining, analysing and extracting of land information, than those utilising 2D representation tools only.

As such, 3D cadastre shall has the ability to (see §2.3.2):

- Describe in 3D the horizontal and vertical boundaries of the spatial units
- Display the 3D characteristics of property (this provides clearer definition of the juridical situation of the property within the multilayer reality)

Furthermore, the corresponding DCDB shall has the following characteristics:

- DCDB based on a coordinated cadastre (the survey accurate digital cadastral map), instead of the DCDB based on the graphically correct digital cadastral database
- DCDB could be arranged in different layers

Surveyed accurate DCDB provides more efficient land market processes, especially those related to the subdivision of land. Various DCDB can be arranged according to accuracy (preliminary adjudication of boundaries by demarcation or pre-computation etc) or to reflect the various stages of subdivision (proposed layer managed by the planning or local authority, surveyed layer (for works pending final approval from cadastral authority) and final layer (the authenticated technical layer). This offers an excellent audit trail (process and data), allowing various land related agencies or parties maintain their database at various stages of development before the final layer is being approved.

5.2.2 Selection criteria

Based on the general guidelines provided by the "*best practices*" (see §2.5) and the Israelis experience [*6*], the criteria selected to evaluate a feasible 3D cadastre are:

- Cost – low implementation cost
- Feasibility – corresponds to existing technological capabilities
- Flexibility – adaptable to local environment
- Relevancy – a long lasting solution
- Continuity – preserves current situation as much as possible
- Technology – employs advanced technologies
- Quality – a solution for all possible situations with appropriate accuracy, quality and legally valid

5.3 Requirements To Develop And Operate 3D Cadastre

The following sections shall evaluate the available options in proposing an appropriate Malaysian 3D cadastre, from the legal, administrative and institutional as well as the technical aspects.

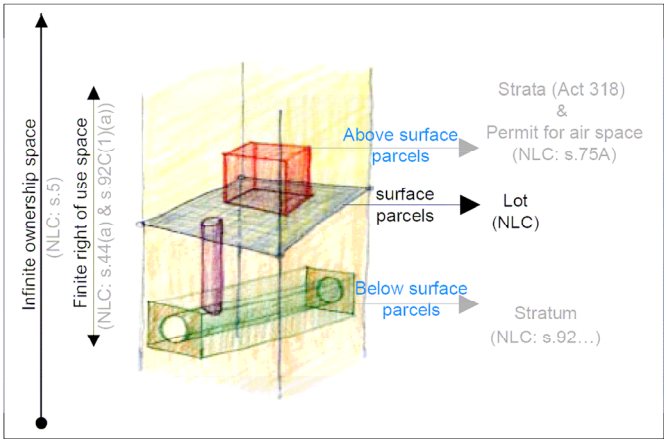
5.3.1 Legal framework

The basic concept of land parcel (lot) in Malaysian land law is the infinite ownership space defined as a cone down to the centre of earth, with boundaries on the surface extends vertically upwards and downwards to an extent "*necessary for its lawful use and enjoyment*" (see §3.2.2).

The basic unit in Malaysian Cadastre is the lot. Its adjudication consists of two parts, first the ascertaining of the physically surface boundaries by surveyed boundary marks (NLC: s.396, see §3.2.7), then the official ascertainment of rights in land via registration and issue of documents of title (see §3.2.4).

However, it should be noted that existing Malaysian Cadastre deals with properties located not only on the surface, but also above and below the surface level. NLC: s.75A deals with permit to use air space above state land or reserved land, while STA (Act 318) facilitates subdivision of building wholly within the lot into parcels. On the other hand, NLC: s.92A – 92I deal with alienation of underground land beneath state land (NLC: s.92C), alienated land (NLC: s.92D) and reserved land (NLC: s.92F), or lease of underground land below reserved land (NLC: s.92F). For all intents and purposes, the rights and responsibilities of the proprietor of the surface parcel shall also apply to the proprietor of the underground land. In other words, the proprietor of the underground land will continue to enjoy the rights to effect dealings, subdivision, partition, amalgamation and even subdivision of building if allowed by the State Authority.

Fig. 42: Legal basis for the definition of 3D spatial parcels



There are also provisions to survey and issue title for strata (STA: s.13, s.15 and s.16[26] and the various DG Circulars) and stratum (NLC: s.92B - s.92F and DG Circular 5/1999). The parcel is defined by the bounding floor, walls and ceiling. Individual parcels are then issued with strata title in accordance to Section 16 after opening of a strata register (STA: s.15). Stratum, the cubic layer of underground land is defined by "*such a depth below the surface to such further depth below such surface*" and "*having such cubic dimensions, its boundaries specified in the document of title*". The document of title shall be in the form of registry title.

On the other hand, the cadastral map or digital cadastral database (DCDB) is only two-dimensional in nature. It contains neither altimetry information nor detailed information of existing objects or structures within the parcel area. The vertical dimensions are only available on the authenticated strata and stratum certified plans, as scanned images in the image library.

The existing condition is very similar to the Israel's spatial sub-parcels principles, whereby the surface parcel space is subdivided into spatial sub-parcels (see *Fig.* 42). This form of spatial registration preserved the existing definition of surface parcel, thus permitting an easier transition from the current surface cadastre to the future multilayer 3D cadastre.

However, current legal framework for spatial registration is also having the following strengths and weaknesses:

Strengths

- Federal Constitution
  - Article 91 provides for the establishment of National Land Council to formulate a national land utilisation policy, comprising of state representation and a federal minister as chairman. The adoption of policies formulated is mandatory, to promote a unified land legislation with standardised rules and regulations (via JKPTG circulars)
- National Land Code
  - There are provisions to deal with the above surface spatial parcel (e.g. infrastructure such as the elevated track of KL Metro as shown in *Fig.* 22). NLC: s.75A allows a permit for use of air space over state or reserved land[27]
  - Other than the famous Plaza Putra under Mederka Square, section 92A – 92G seem to also provide a possible solution for the registration of underground utilities and transportation tunnels (nevertheless the whole object will be irregularly partitioned by the many intersecting surface parcels, a potential source of data inconsistency as attributes of a single object are repeated in the resulted stratum parcels)
  - There seems to have sufficient provisions to subdivide land into three spaces – surface, above surface and below surface. This shall provide the required foundation for the transition from 2D surface cadastre to the multilayer 3D cadastre. Section 92C, 92D and 92F seems to imply that Government prefer local rather than general settlement

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STA: s.13: Action by Director of Survey after approval of subdivision.
STA: s.15: Preparation and maintenance of strata register.
STA: s.16: Documents of strata title.

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NLC: s.75A: The State Authority may in accordance with the provisions of this Chapter and of any rules under section 14 approve the issue of a permit for a period not exceeding twenty-one years for the purpose of erecting, maintaining and occupying a structure on State land or reserved land, or over State land or reserved land as an adjunct to any structure on the adjoining land.

(multilayer land settlement). This is desirable as the process of defining the boundaries in all three spaces is tedious and costly. Land settlement (process to finalise common boundaries among interested parties before or after physical adjudication of boundary on the ground [*52*]) is only being carried out when and where it is required

Weaknesses

- Federal Constitution
  - As land is a state matter, it can be expected that interest of each state will prevail over national interest. The adoption of national land policy is difficult though not impossible. Sabah and Sarawak are allow to have its own land policy as Article 95E excludes them from this obligation
  - Distribution of legislative powers at federal and state level prevents the integration of the legal registry and cadastral survey and mapping into one unified cadastral registration system. While both were parallel used and mutual exchange of data did took place (as cadastral map served as common basis for land register), the fact remained that eventually this resulted in double data registration. Data originated from another sources were no longer authentic (as compared to the home database), which in turn cast doubt in the use of these data. Some defects of a non-unified land registry system will be deliberated in §5.3.2
- National Land Code
  - The division into Registry and Land Office titles has been the legacy of the British. Similar registration processes have been duplicated all over the state, the districts and even sub-districts. A single land registration throughout the state is the better option to facilitate an active land market
  - NLC provides for the traditional mode of subdivision to allow registration of individual ownership. The road and open space are automatically surrendered as public reserve, and by default it does not provide for common area. This hinders the development of the closed community lifestyle with one or more types of residential units, comes with common areas and amenities or the so-called gated communities (see §3.4.4)
- Strata Title Act
  - Section 6's limitation on buildings capable of being subdivided to "*building or buildings held as one lot under final title*" is rather restrictive. This hinders the development of innovative cross boundaries building construction and further aggravated the issuance of strata titles as the conversion process (amalgamation of two or more lots into a single lot or conversion from QT to FT) might take years to complete
  - Subdivision of building involves boundaries defined by the building, which in turn forms the strata title. However, the basis of strata subdivision in accordance to section 6(1)[28] is deems too restrictive, involves subdivision of building and not land. There is now a demand to widen the scope of strata title to include "*landed strata*" and single storey housing units, to cater to the new stratified residential housing schemes such as the GC

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STA: s.6(1): Buildings capable of being subdivided. (1) Any building or buildings having two or more storeys on alienated land held as one lot under final title (whether Registry or Land Office title) shall be capable of being subdivided into parcels; and any building or buildings having only one storey on the same land shall also be capable of being subdivided into parcels to be held under strata titles or into accessory parcels.

Another point to take note is that an appropriate legal framework requires not only sound land legislation, but also legal institutions and a justice system to enforce the rule of law. Issues like fraudulent transfer of land and properties, as well as inaction against errant developers over non-issuance of strata title do not bode well for the nation. Land proprietors should have the confidence and secured occupation, before the land market can function with confidence and security.

5.3.2 Administrative and institutional framework

The cadastral system comprises a land registration system and a cadastral survey and mapping system as key components. Land registration is a state government responsibility while cadastral survey and mapping is under federal jurisdiction.

Experience in developed countries has shown that stand-alone or isolated approaches where data and processes were maintained separately are not sustainable. A non-unified land registry system is known to have the following shortcomings [*35*]:

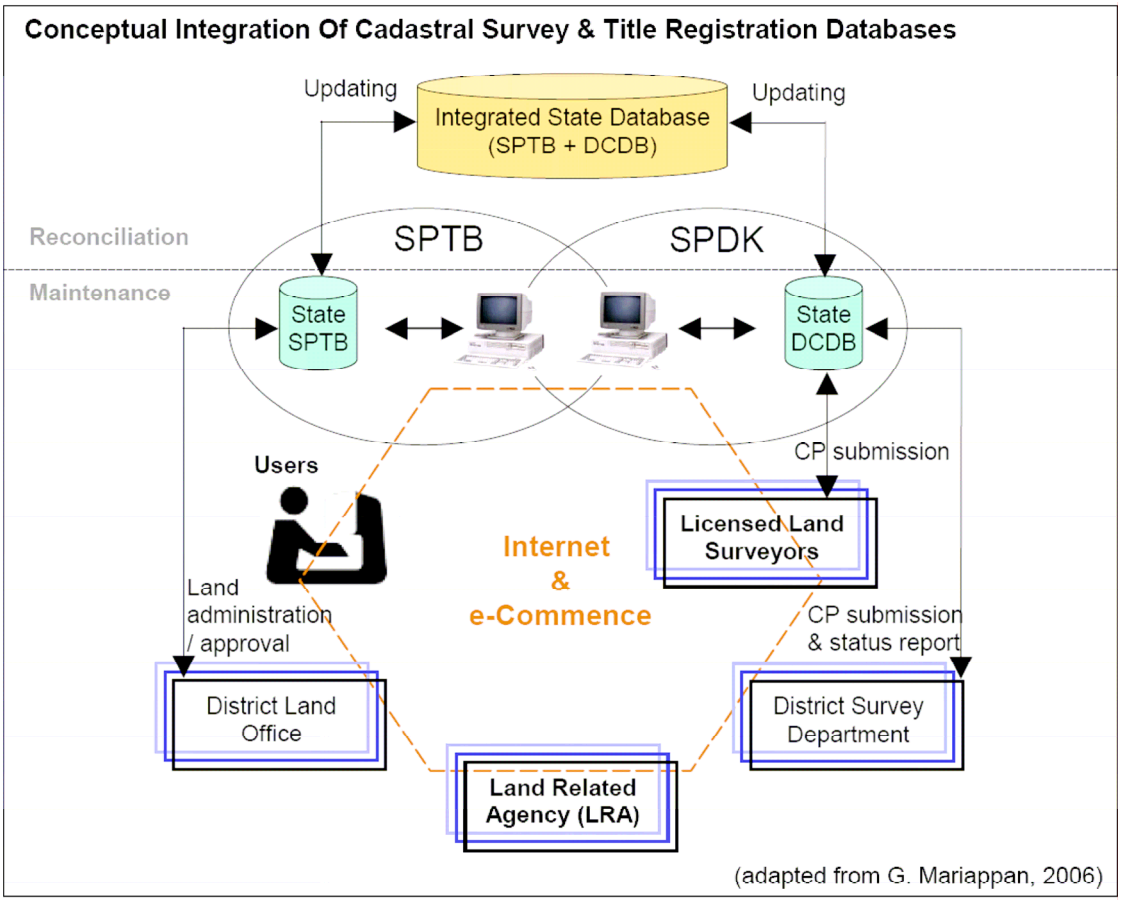
- Legal administrative and cadastral mapping data integrity is not well maintained (huge backlog of QT and incomplete DCDB as discussed in §3.4.1 and §3.4.2)
- Work flow, data updating and data service are less efficient (incomplete DCDB as stated in §3.4.1 and patches of irregularities as shown in Table 5: Coverage of SPTB and DCDB)
- Quality and consistency of information are difficult to maintain due to parallel registration and updating
- Less cost effective (examples include overheads to deal with two separate government departments for one land related transaction – one might be located at the state capital but the other at district, or extra efforts to ensure data integrity during data exchange as both set of records are inter-dependant)

Integration of the cadastral databases (SPTB with DCDB)

With the present advent of modern technologies such as GIS, Internet and web based applications and in conjunction with the NSDI (MyGDI) initiative, DCDB and SPTB could be integrated electronically. Furthermore the integration of the spatial database of DCDB with the textual database of SPTB is the prerequisite requirement for the formation of a comprehensive land information system, initially at the district level, then to the state and eventually at the national level.

There is currently a research to investigate how best these two standalone databases can be possibly integrated. G. Mariappan [*22*] proposed a mechanism to integrate these two databases. Coordination between JUPEM, PTD and PTG can be provided by the installation of centralised server or distributed server at each of their offices. These servers act as the transporters and bridges in exchanging data between DCDB and SPTB. Conceptually the proposed process can be illustrated as in figure below:

Fig. 43: Conceptual model to integrate SPTB and DCDB (adapted from [*22*], and the original integration conceptual model and digital data maintenance network model are listed in Appendix E).



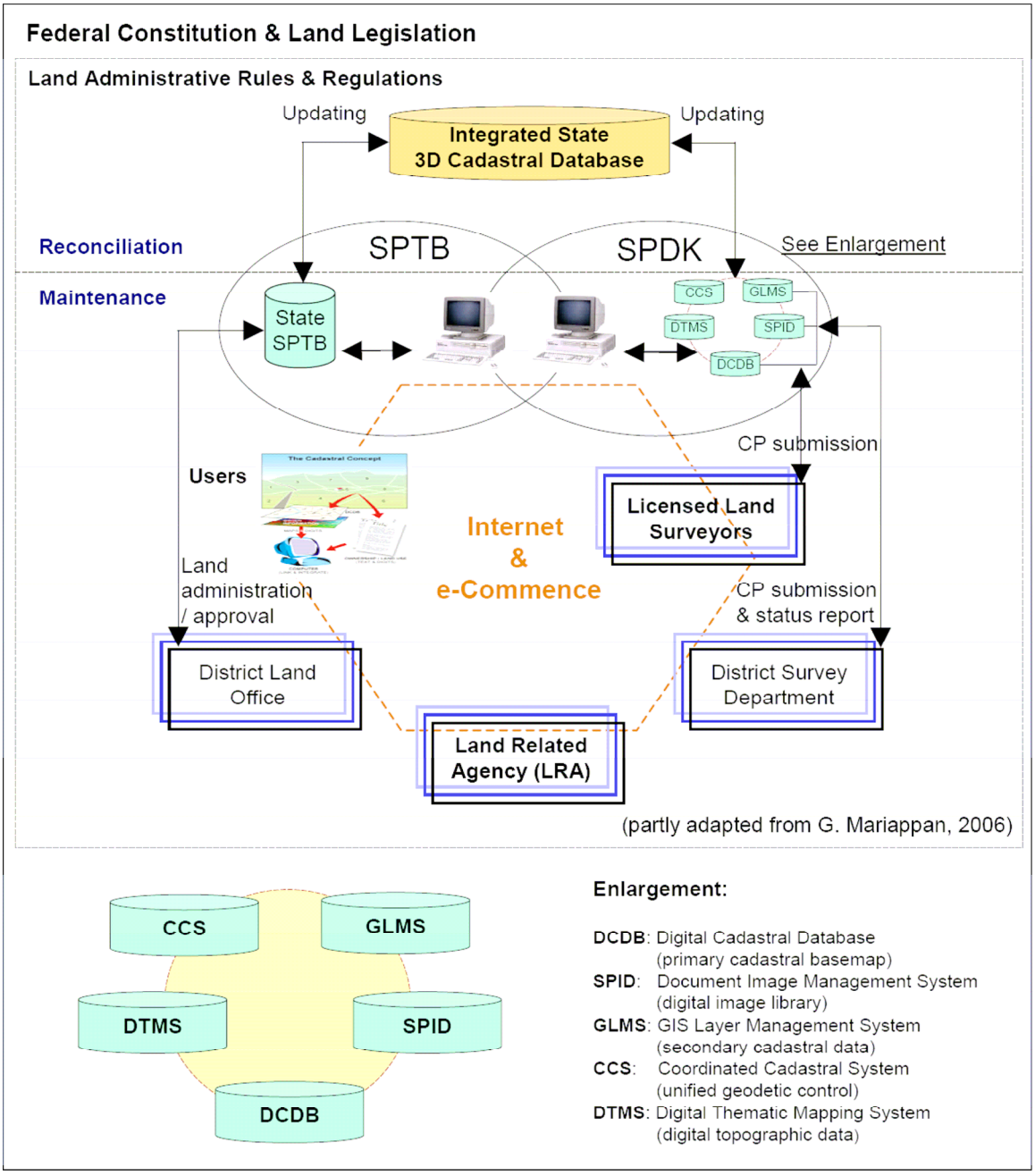
Nevertheless, though the benefits from an integrated cadastral database with graphic and title registration are many, but there are many hurdles to cross at current stage of practice. G. Mariappan [*ibid*] underlines the following issues associated with the proposed integration:

- Organisational - there is no mechanism for exchanging data among organisation
- Technological – compatibility of existing hardware and software
- Data - data quality and integrity
- Legal - data custodian and rights
- Different working procedures and practice

Integrated cadastral databases with vertical component

With only the 2D cadastral basemap and scanned images of CP, SPDK has yet to define an appropriate mechanism for the vertical dimension, in particularly the strata and stratum records. Combining the work from G. Mariappan [*22*] and the current JUPEM initiatives such as the secondary digital cadastral database (GLMS), unified geodetic control (CCS) and digital topographic database; an additional vertical component could be incorporated into the previous model. Thus conceptually a Malaysia 3D cadastral model could be possibly conceived as below:

Fig. 44: Conceptual model for a possible Malaysia 3D Cadastre (extended from *Fig.* 43).



The proposed vertical component is maintained within the JUPEM environment as:

- JUPEM being the provider and custodian of survey and mapping data, with all the relevant databases (DCDB, SPID, GLMS, CCS and DTMS)
- DCDB and SPID, the digital certified plan image library is created and maintained by JUPEM within one system (i.e. SPDK)
- Land Office deals mainly with administrative database, may not have the facilities and know-how to work with geo-DBMS

5.3.3 Technical framework

As cadastre is being defined as "*a parcel based and up-to-date land information system containing a record of interests in land*" and "*includes a geometric description of land parcels*", thus it is obvious that the technical issues are mainly associated with land surveying and information and communication technology (ICT). Evolution of the modern cadastre is traditionally dependent more on technology than what is technically possible [*63*].

Malaysia has a rather comprehensive and advanced survey and mapping system, capable to deal with the boundaries adjudication on the ground up to the storing and supplying of information. What it requires at the moment is to review the current 2D based cadastral registration, to investigate how should it be enhanced or extended to support 3D registration.

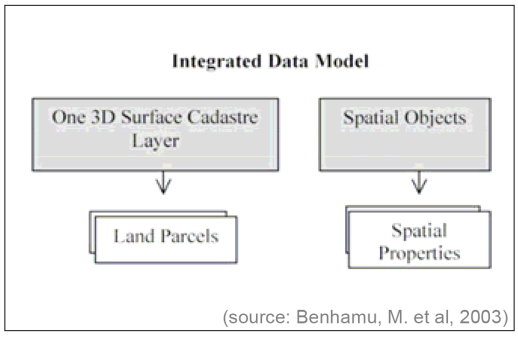
Technically the objective of 3D registration can be achieved through the following processes:

- Definition of 3D spatial parcel
- Incorporating the vertical dimension into the existing 2D DCDB, to create the 3D DCDB
- Provide suitable graphic software for 3D visualisation

Definition of 3D spatial parcel

The Israelis spatial sub-parcel concept is similar to Malaysian current division of land units into lot, strata parcel and stratum (see *Fig.* 42). Israel further proposed using the integrated data model to manage the multilayer information. This information database is consists of only one 3D spatial layer (no division into surface, above and below surface layer), with spatial parcels defined as objects linked to the existing 2D surface parcels. This has the advantages of continuity and relevancy - current surface cadastre is preserved and is appropriate to present multilayer reality as most of the activities are still in the surface. There is also a link between the surface and multilayer information [*6*].

Fig. 45: Spatial information management model [*ibid*].



Israelis cadastral block map allows the consolidation of the partitioned spatial sub-parcels within a registration block into one spatial parcel. Unfortunately this is not feasible in Malaysia. One possible alternative is to assign a unique object ID linking to these intersecting sub-parcels (whole and part registration, similar to the unique network identifier proposed by the Dutch cadastre for tagging cable and pipeline network partitioned by the intersecting surface parcels [*9*]).

The upgraded version of SPDK with the secondary cadastral database (GLMS, see §3.4.1) is the right approach to manage DCDB into various "*layers*". This is to reflect the different stages of survey (e.g. proposal layer and approval layer to be maintained by the local government or planning department and land office respectively; surveyed layer under surveyor management and the final surveyed accurate technical layer under Survey Department). The data trails can be properly tracked and then subsequently upgraded accordingly by the rightful custodian. With this arrangement, current data inconsistency between land office and survey department (also with the other land related agencies) can be minimised.

Extending to the third dimension

The cadastral database, being "*a database showing the boundaries of subdivisions of land… containing particulars such as land parcel dimensions, its area as well as its unique parcel identification number*" [*15*] has no altimetry information. DCDB has neither "*footprint*" (see footnote 25, footprint was only shown the respective strata and stratum CP) nor any indication on the existence of strata or stratum parcel. Strata certified plan indicates only the height of the storey (vertical section of the building) while the stratum certified plan has all corners of the volumetric parcel surveyed with reference to the national vertical height datum (DG Circular 5/1999 [*ibid*]). The height or the z-coordinates are not maintained within a database, but organised as scanned image in TIFF format within the certified plan image library (see §3.3.2).

Following the example of Israel, one alternative is to have a complete 3D representation of the spatial sub-parcels while the surface parcels remained as 2D representation but with additional heights at the lowest and highest points. A complete 3D representation is believed to enable accurate registration, management and definition of multilayer reality [*6*].

The existing multilayer information presentation on the strata and stratum certified plan could be further improved to include also various sections for better definition of 3D reality (see the Queensland example in §4.4.3 and Appendix D). With more elaborate measurement (using 3D points to identify the position, shape and dimensions and at various sections), 3D information can be analysed and examined from various perspectives. For complex situations, digital snapshots of the construction (such as the digital panoramic images from the cyclorama) can also be included to improve visualisation.

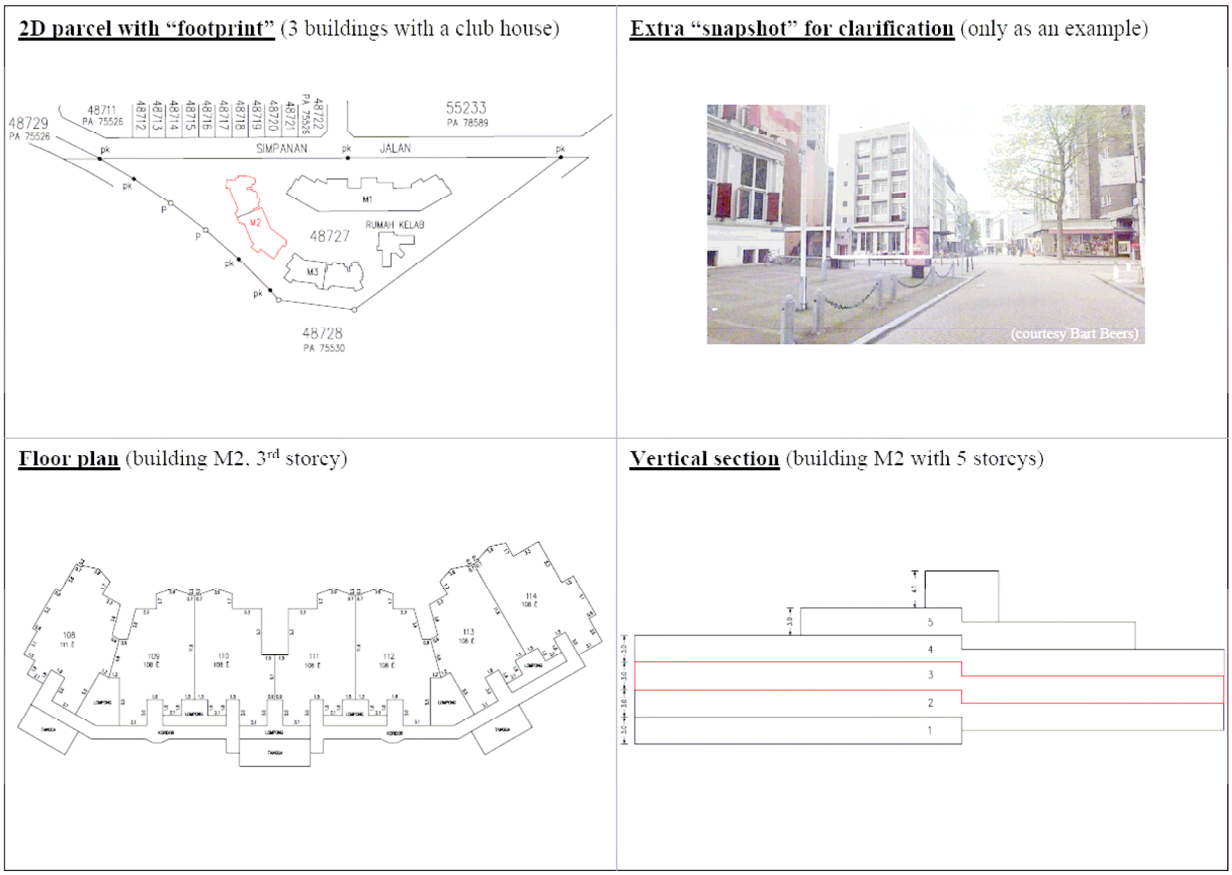
If required, the third dimension can be extracted from the existing digital terrain models (generated from JUPEM existing Computer Assisted Mapping System [*15*]). And in the near future, a better set of height values can be extracted from the new mapping program for large scale digital topographic data, with an unified coordinates system based on RSO, with referenced to GDM 2000 horizontal datum (see §3.4.2 and DG Circular 1/2006 [*ibid*]). Judging from the existing cadastral framework, obtaining the required vertical dimension may constitutes the biggest bottleneck in establishing a Malaysian 3D cadastre.

3D Visualisation

The ability to display 3D characteristics of properties allows a better definition of the judicial situations within the multilayer reality. 3D representation provides better examining and analyzing tools than those by 2D tools alone, as ambiguity does arises when 3D reality is represented on 2D flat surface (see §2.3.2).

The cost of complete modelling of 3D object will be costly. The cheaper alternative shall be by visualising the 3D spatial representation from various perspectives and sections. For example, strata development can be displayed from the following views:

Fig. 46: 3D visualisation from the index plan, floor plan and vertical section (extracted from Appendix B2) and the extra snapshot for clarification (courtesy Bart Beers).



Additional information that can be included in these perspectives includes the sectional views for the associated accessory parcel, tabulation on the parcel's share unit, snapshots on the interior of the building etc.

5.4 Implementation Of A 3D Cadastre

The conceptual models of 3D cadastre ranges from full 3D cadastre supporting volume parcels, to one that similar to the traditional cadastre where the stratified situations are maintained via 2D parcels.

Full 3D cadastre that supports both infinite parcel columns (defined by 2D surface parcels) and volume parcels is deemed to offer the best long term potential in fulfilling the requirements for cadastral registration [*50*]. This model provides a strong link to the current 2D registration, yet it is still possible to establish volume parcels that no longer related to the surface. However this model is rather impractical to implement at this stage (see §2.4.2), thus the search for possible solution shall be evaluated from two perspectives, initially for a short and medium term future and then a long-term future, based on the criteria listed in §5.2.2.

5.4.1 Prerequisites

The following basic conditions are however need to be fulfilled before launching any possible 3D registration, namely:

- Complete surveyed accurate DCDB that represent a continuous digital title plan
  - Enhancing the DCDB, to overcome issues raised on backlog of QT (see §3.4.1) and incomplete DCDB (see §3.4.2)
  - Integrate the SPTB and DCDB Initially at state level, then proceed to NDCDB – this is to ensure a seamless, complete and up-to-date cadastral information (see §5.3.2)
  - Information on parcels and interest in land in 3D – with proper definition of 3D spatial unit managed in geo-DBMS and ability to visualise in 3D (see §5.3.3)
- Legislation that safeguard the private right of the property and public rights in land
  - Review the existing land laws that failed to satisfy the needs of modern development – NLC and STA in current form provide insufficient framework for "public area" and "common facilities" under the cluster housing concept (see §3.4.4 and §5.3.1)

With these two prerequisites are in place, the discussion can now proceeds to evaluate the available options.

5.4.2 Short to medium term solution

Table 4 (see §3.3.4) demonstrated why there is a need for 3D representation:

- Out of the close to 5 million units of residential housing development under various stages of construction in Year 2005 nationwide, some 1.6 million are high-rise units
- There are billions worth of property without proper cadastral registration, examples are the underground food, leisure cum entertainment complex in Plaza Putra, more than 180 km long of transportation metro and unknown length of utility cable and pipeline buried under the surface

Furthermore, the following reports highlighted the effects of "dead capital" by de Soto [*13*]:

- "Non-availability of strata title represents 27% of the total complains received by Housing Buyer Association in the second year running" (Memorandum to Ministry of Land and Cooperation Development on Strata Title Jam, by National House Buyer Association, Malaysia, April 17, 2003)
- According to the 2005 Auditor General's report on Penang: there are 82% (17,661 out of total 21,547 delivered units) of the landowners of high-rise construction failed to apply for strata title, resulting in lost of land revenue in application fees of RM 1.77 mil and fines of RM 6.29 mil to 62.9 mil (thestar.com.my, Sept 9 & 14, 2006)

Judging from the existing frameworks, **2D cadastre with 3D tags** shall be the best option to start with in the very near future, possibly within one to five years' time.

Factors that favour 2D cadastre with 3D tags as a short and medium term solution are:

- Cost (fast and low cost to implement)
  - No additional cadastral surveying work is required (to extract the vertical dimension)
  - Using almost all the existing infrastructure (hardware, software, data and routines)
  - No drastic change to current working procedure
- Feasibility (corresponds to existing technological capabilities)
  - Existing routines can be easily incorporated to provide the searching mechanism for the tagged drawing via the unique parcel identifier of the 2D parcel
  - Basic 3D visualisation on floor plan and section is the basic functionality of current software and hardware
- Flexibility (adaptable to local environment)
  - Based on current legislation, without the need for extensive legal reviews
  - 3D representation resolving most of the limitations on current 2D registration
- Relevancy (a long lasting solution)
  - Simple starting point yet at the same time incorporate sufficient components to allow the system to grow and evolve into a mature system
- Continuity (preserves current situation as much as possible)
  - Solution just an extension from the current system
- Quality (with appropriate accuracy, quality and legally valid for all possible situations)
  - The administrative land registration system (SPTB) and the cadastral data management system (SPDK) are both fully computerised, with the surveyed accurate DCDB and certified plan image library
  - Strata and stratum certified plans digitally maintained within the certified plan image library provide the all important "*3D tags*", the reference link for 3D visualisation

The advantages of this proposed cadastral system over current registration include:

- Complete registration of 3D rights, with explicit reference to volume of space
  - Rights in 3D space are well defined and well represented – permit for air space by infinite column of air space, strata parcel by walls and ceiling and stratum volume by bounding surface with corners denoted with absolute coordinates
  - 3D representation can be further enhanced through more elaborate survey (such as the Queensland's survey plan for volumetric parcel, showing details at various sections)
- Good accessibility to the legal status of stratified property
  - A single opening to access both administrative and graphic data simultaneously (an integrated environment[29] can be created to combine current standalone SPTB and DCDB databases)
  - 3D representation is stored as digital drawing (instead of hard copy in document of title)
  - 3D spatial information can be accessed via the unique parcel identifier of the surface parcel (automation instead of manually search for the associated hard copies)
  - The reference link (3D_link: url_string) tagged to the surface parcel enables 3D visualisation in the form of viewing the 3D parcel from various perspectives (for example examining the strata parcel in conjunction with the associated accessory parcels within the various windows, instead of flicking through the numerous strata certified plans)
  - The visibility of the stratified situation can be further enhance to include the snapshots of the property from the exterior and exterior, or the panorama images if any

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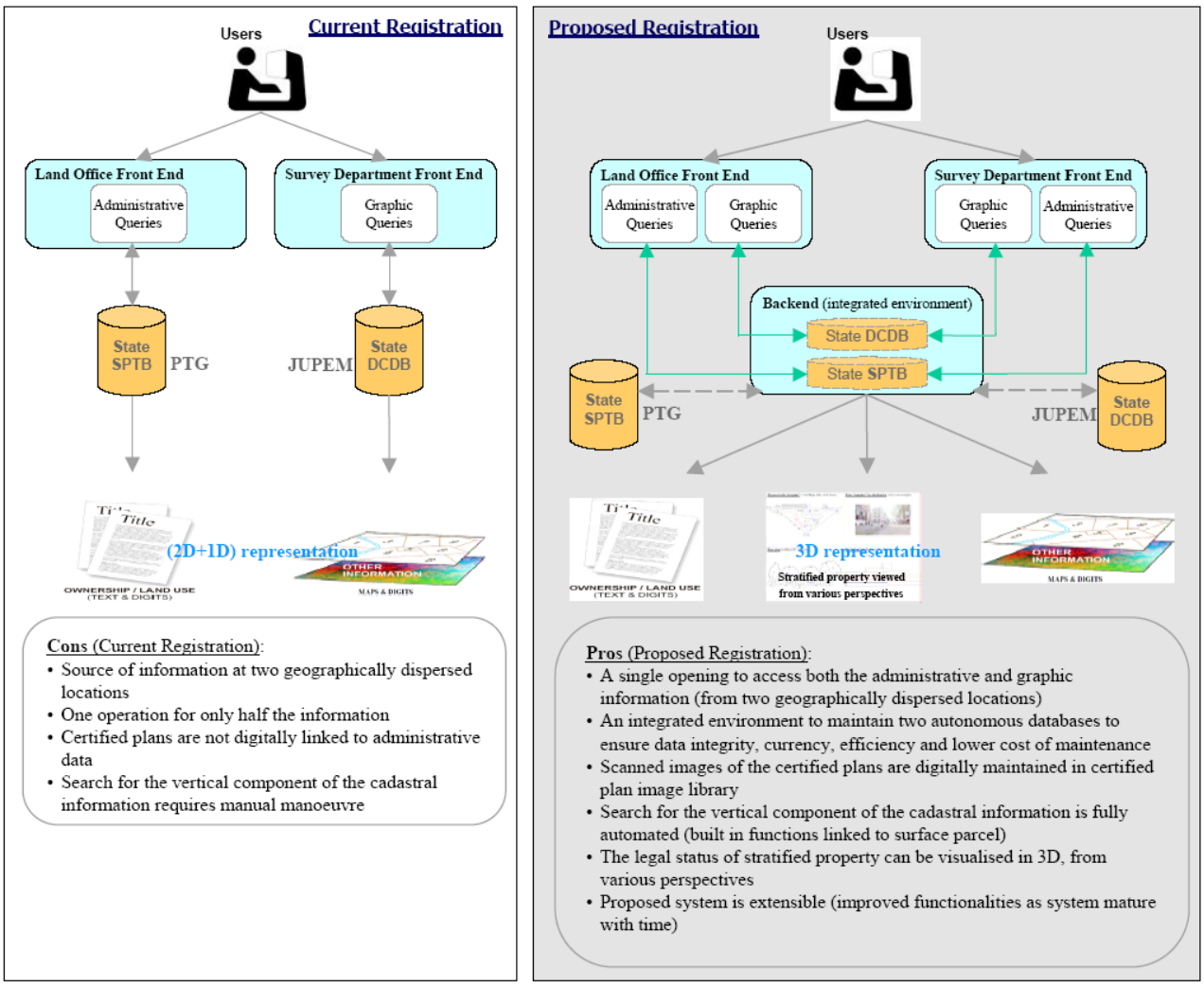
One alternative is by merging together these disparate databases. Another contrastable alternative is by the so-called federated database system whereby multiple autonomous database systems can be transparently integrated into a single federated database. The constituent databases are interconnected via computer network and may be geographically decentralised (en.wikipedia.org).

Fig. 47: Comparison between the existing cadastral system with the proposed 2D cadastre with 3D tags.



Nevertheless 2D cadastre with 3D tags provides no optimal solution, the inherent weaknesses are:

- Tagged image purely for the purpose of viewing
- No linkage to current administrative database, thus offers no capability for analysis
- Existing shortcomings within the current registration have not been resolved in total
  - Limitations in current legal framework (see §3.4.4 and §5.3.1)
  - Multilayer land settlement is bypass
  - Better definition of 3D representation in cadastral survey, to include elaborate 3D survey plan as in Queensland and extend the DCDB with height based on national datum (see §5.3.3)
  - Absent of absolute height level defined in national reference system (instead of the relative height in the strata case) to ensure data consistency in case of update

5.4.3 Long term solution

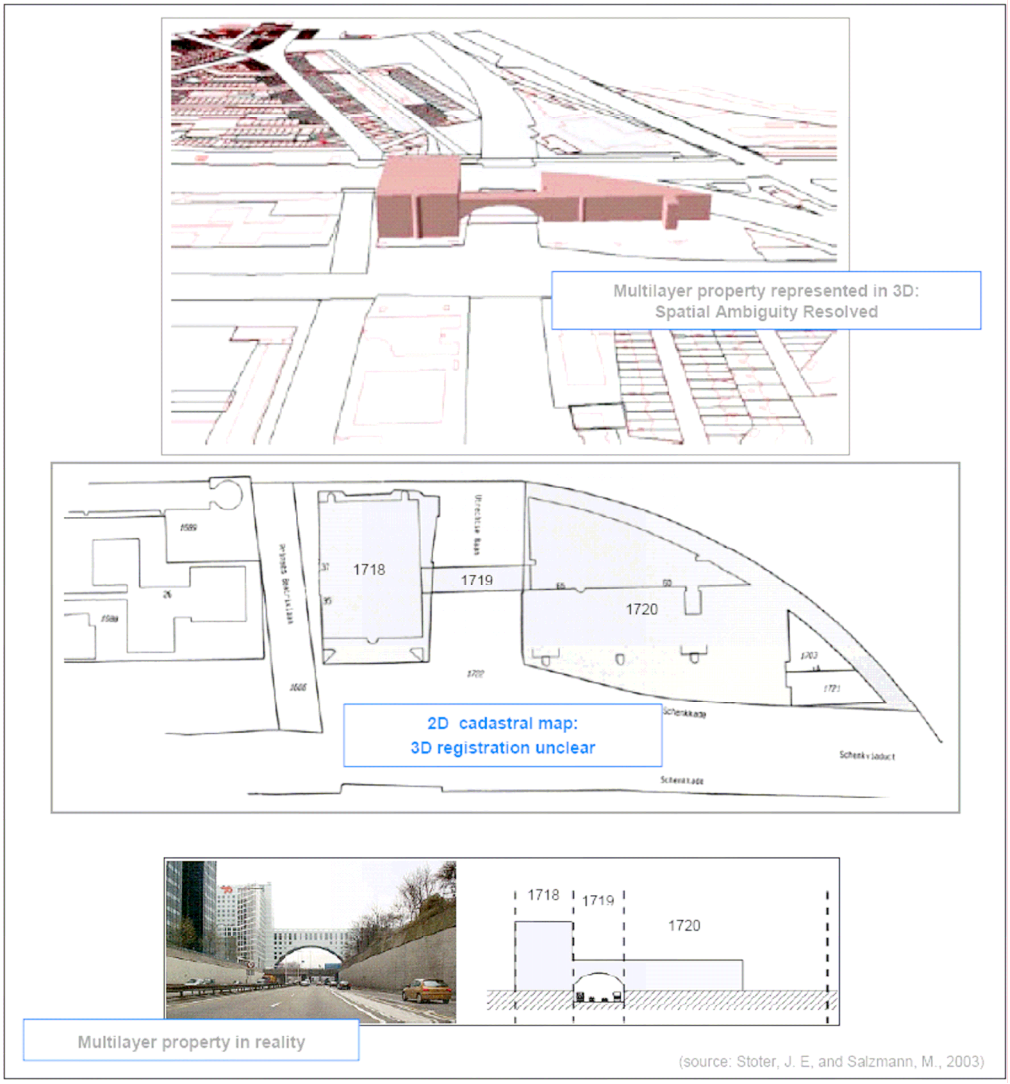
Full 3D cadastre was evaluated as the most sustainable solution for 3D registration, where land ownership should be ultimately able to relate to both the unconstrained parcel columns defined by boundaries on the surface and bounded volume of space (Stoter [*50*]).

The pace of current and foreseeable future development for the nation may not justify the high implementation cost of this ideal long-term solution. However, full 3D cadastre is both feasible and viable if and when the need arises.

Full 3D cadastre can be realised, when the legal basis, the cadastral registration and the property transaction protocols are in place to support the establishment and conveyance of rights explicitly in 3D space (3D rights, instead of the traditionally focus on 2D surface). This amount of overhead involved in the implementation is daunting. The stringent demand on the legal, administrative and institutional and technical aspects of the implementation can be summarised as below:

- Review or modification to the existing land law
  - Certain sections of Federal Constitution, NLC and STA have not been conducive to modern development with vertical component (see §5.3.1)
  - State land rules need to be amended to accommodate the change of the basic unit of land from surface area to volume. The corresponding forms, schedule of rate (to determine land revenue) all need to be amended accordingly
  - Legal review is normally a complex and lengthy process, and complications might arises
- Multilayer land settlement
  - The process of finalising common boundary before or after the physical adjudication of boundary among the interested parties itself is tedious and complicated
- Changes to the technical requirements (see §5.3.3)
  - Define and manage 3D objects with linkage to current 2D cadastre
  - Populate the vertical dimension
  - Ability to provide functions for visualisation and analysis in 3D
- Improved workflow management between cadastral survey and land registration
  - The close cooperation between the federal survey and mapping agency and the very influential state land office is another issue to content with. Both have vastly different organisational arrangement, technical compatibility, data quality and working procedures and practice (see §5.3.2)

Fig. 48: Ideal full 3D cadastre with 3D representation (source: Stoter et al, 2003).



Looking back, it is rather obvious that although full 3D cadastre is the ideal option, it is definitely not a viable solution for Malaysia 3D registration, certainly not in the near and medium future.

6. CONCLUSION

This thesis has discussed the role of land as our most valuable resource, thus the control over land (ownership) has great economic, socio-political and even religious implications. The information on '*who*' '*hold*' '*which*' parcel of land is essential to ensure that land is managed sustainably for the present and future generations.

Traditional cadastre is based on division of land into 2D surface parcels, and the ownership rights are subsequently registered on these parcels. Most 2D registrations are found to be adequate as long as the whole column of space belongs to one or a group of persons. Unfortunately (or rather fortunately) intensive use of the land and technology have made it possible to have many different type of uses simultaneously above and below one another. This has resulted in multiple use of space, whereby the same land parcel is held simultaneously by several persons, either as owner(s) or rights or interests holder. These legal situations can no longer be portrayed effectively on flat surfaces.

Being an essential tool in administering the man-land relationship, cadastre is constantly evolving in response to the changing man to land relationship within that particular society. So the focus of this research is to search for the "*most appropriate*" cadastral system which can protects land rights effectively, efficiently, simply, securely and affordably for Malaysia. The selection process emphases on using "*best practice*" as guidelines to evaluate current registration, in comparison to the 3D registration practiced in the developed countries for a viable solution basing from a broad range of similar phenomena.

Judging from current legal, organisational and technical frameworks, **2D cadastre with 3D tags** shall be the most viable 3D cadastral system for the **short to medium term future**, possibly within one to five years' time. The rationale being:

- Fulfilled the most rudimentary requirements of 3D cadastral registration
  - Describe in 3D the horizontal and vertical boundaries of the spatial units
  - Displays 3D characteristics of property, providing clear definition of the juridical situation of the property within the multilayer reality
- Preserved current cadastral registration
  - SPTB with the digital land registration database while SPDK with the surveyed accurate DCDB and certified plan image library
  - "*3D tags*" in the form of (3D_link: url_string) can be easily incorporated into current system for 3D visualisation with views from the top (index and floor plan) and side (vertical section)
- Based on current legislation, bypassing the often long winding legal reviews
- Fast and low cost to implement
  - No additional cadastral surveying work is required
  - Using almost all the existing infrastructure
  - No drastic change to current working procedure
- Simple and fast starting point, yet at the same time incorporate sufficient components to allow the system to grow and evolve into a mature system

Nevertheless, 2D cadastre with 3D tags provides no optimal solution in the long run as it has the following limitations:

- Tagged image purely for the purpose of viewing, without capability for analysis
- Existing restrictive legal provisions have not been resolved
- Existing 2D DCDB have not been extended with the vertical dimension based on national height datum

Full 3D Cadastre was evaluated as the **most sustainable solution**, but its implementation at this stage is rather impractical. The required overheads are definitely mammoth and costly, namely:

- Review or modify the existing provisions in the NLC, STA and the respective state Land Rules to safeguard the private rights of the property and public rights in land
- Appropriate multilayer land settlement among the adjoining spatial units
- Technical considerations
  - To define the 3D objects and to manage the objects database with appropriate linkage to current 2D cadastre
  - To populate the required vertical dimension, either from existing survey records or existing topographical database or fresh survey
  - To provide functions for visualisation and analysis in 3D
- Improved workflow management between cadastral survey and land registration
  - To iron out the compatibility issues in the technical capability, data quality and working procedures and practice between the two agencies (survey and land offices)

It can be safely concluded that 3D registration is both feasible and attainable, either in the short to medium future or in the long-term future. No matter what, the existing SPTB and DCDB need to be integrated into a seamless land information database, initially at the state level, then proceed to the national level. The quality of cadastral data is of utmost important as investors and the general public look for secured land tenure to develop a healthy and active land market.

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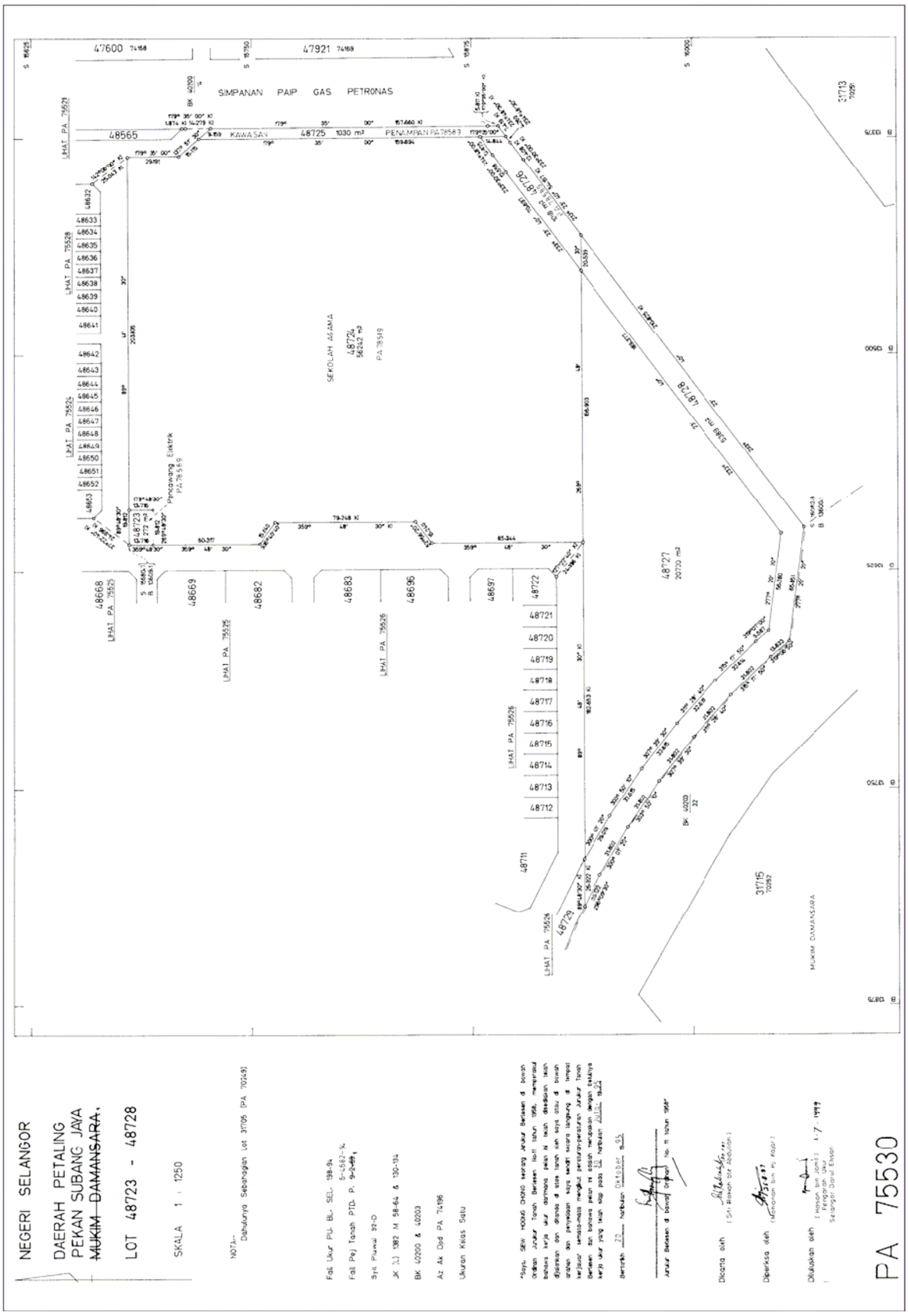
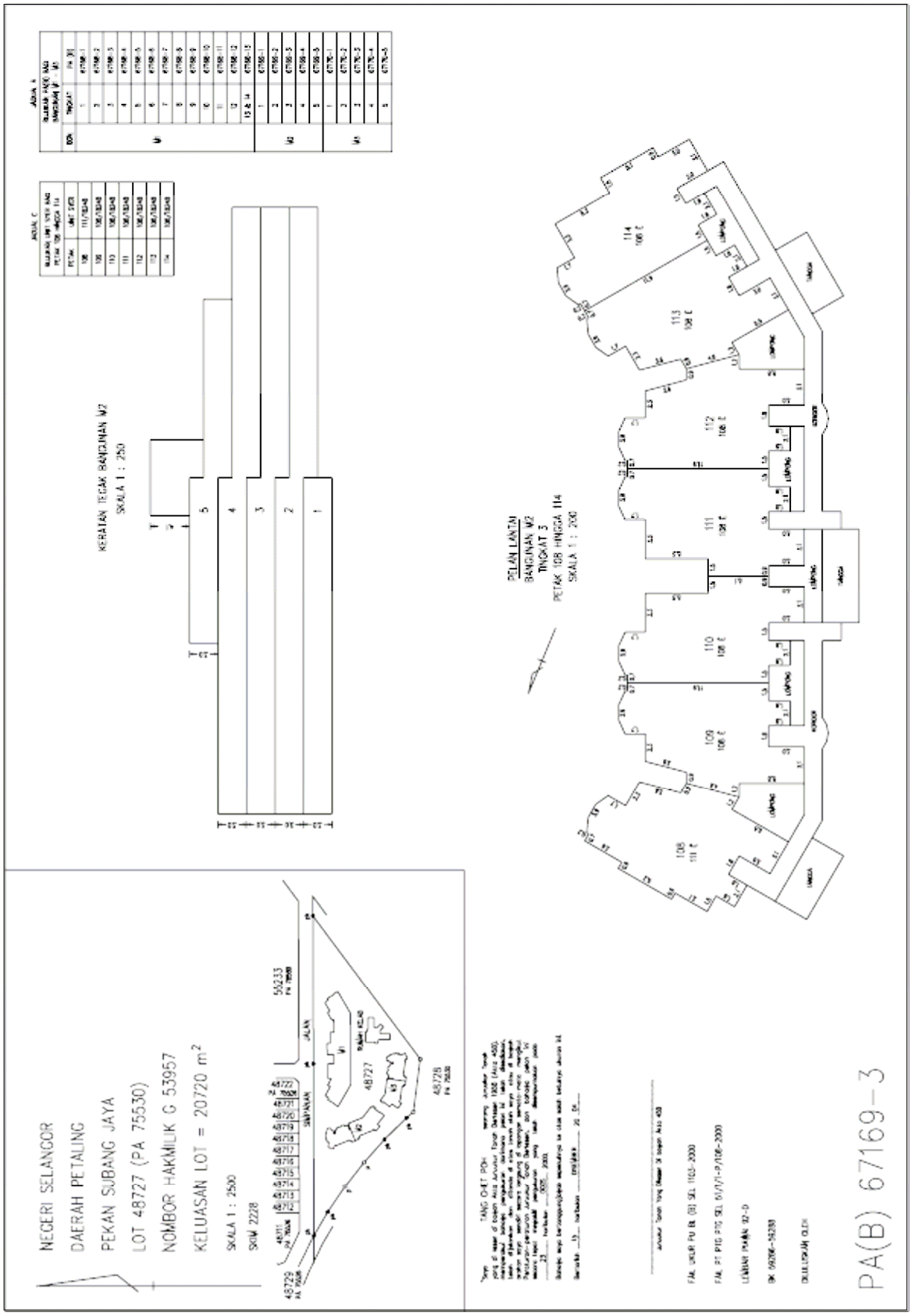
Appendix A: Abbreviations

Abbreviation	Description
§	Section
AKR	Automated Cadastral Registration
CCDM	Core Cadastral Domain Model
CCS	Coordinated Cadastral System
CCTV	Closed circuit television
CP	Certified Plan
DBMS	Database Management System
DCDB (or PDUK)	Digital Cadastral Data Base
DG Circular	Director General Circular
DHDK	Computerised Register Document of Title
DHKK	Issued Computerised Register Document of Title
DTMS	Digital Thematic Mapping System
EIU	Economist Intelligence Unit
et al	Latin meaning "and others"
FDI	Foreign Direct Investment
FIG	International Federation of Surveyors
FT	Federal Territory
FT	Final Title
GC	Gated Communities
GDM 2000	Geocentric Datum of Malaysia
GLMS	GIS Layer Management System
ibid	Latin, short for "ibidem," "the same place"
JKPTG	Department o Director General of Lands and Mines
JUPEM	Department of Survey and Mapping
Kadaster	Dutch Land Registry Office
LKI	Information System for Surveying and Mapping
LRA	Land Related Agency
MyGDI	Malaysia Geospatial Data Infrastructure
NDCDB	National Digital Cadastral Database
NLC	National Land Code (Act 56)
NRE	Ministry of Natural Resources and Environment
PCGIAP	Permanent Committee on GIS Infrastructure for Asia & the Pacific
PTD	District Land Office
PTG	state Lands and Mines Department
QT	Qualified Title
RS	Requisition for survey
SAPD	Automated District Survey Office System
SPDK	Cadastral Data Management System
SPEK	Quality Assurance System
SPHT	Land Revenue Collection System
SPID	Document Image Management System
SPTB	Computerised Land Registration System
STA	Strata Title Act (Act 318)
TOL	Temporary Occupation License
UNECE	United Nations Economic Commission for Europe
UNFAO	Food and Agriculture Organisation of the United Nation

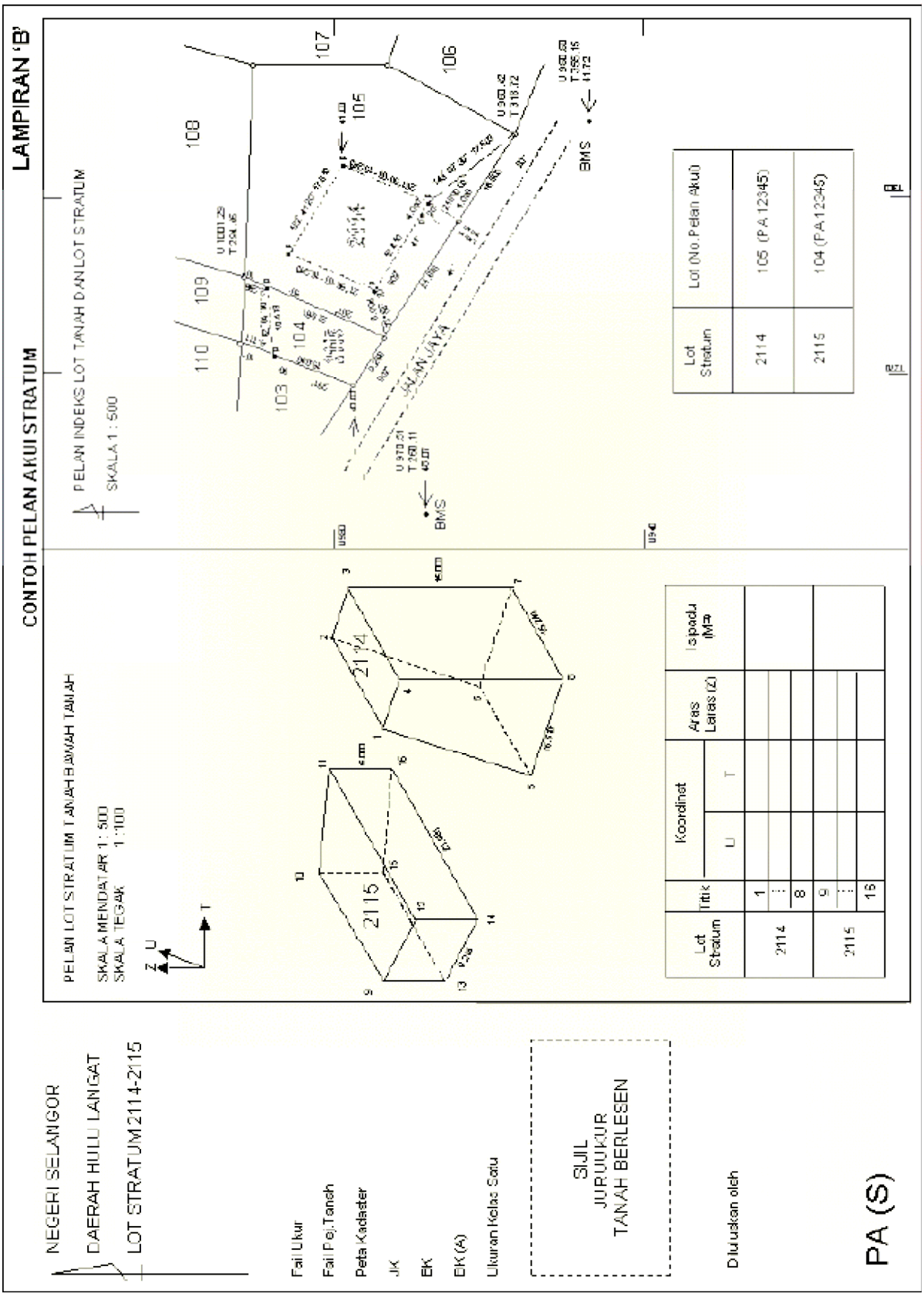
Appendix B1: Malaysian certified plan (courtesy Mahyuddin & Siew)



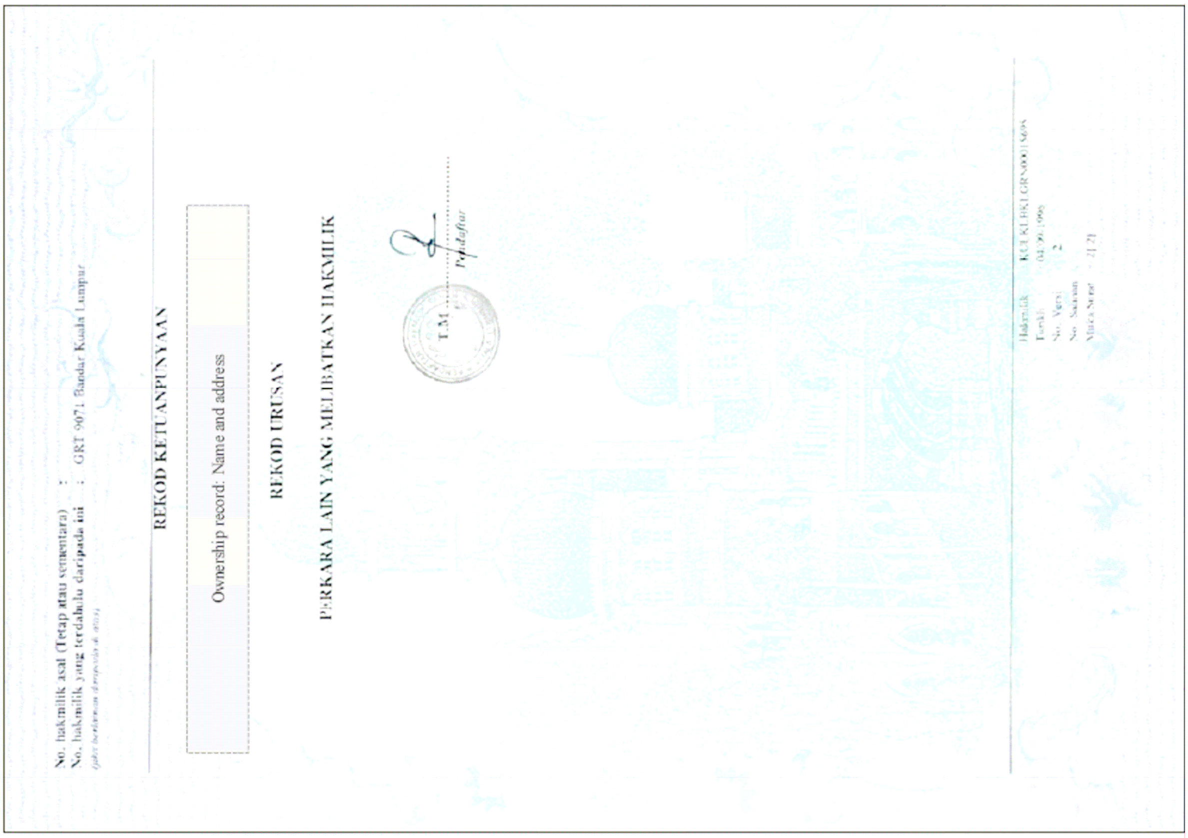
Appendix B2: Malaysian strata certified plan (courtesy Mahyuddin & Siew)



Appendix B3: Malaysian stratum certified plan (source: JUPEM)



Appendix C1: Malaysian document of title – page 1 & 2 (courtesy Mahyuddin & Siew)


No. hakmilik asal (Tetap atau sementara) :
No. hakmilik yang terdahulu daripada ini : GRT 9071 Bandar Kuala Lumpur

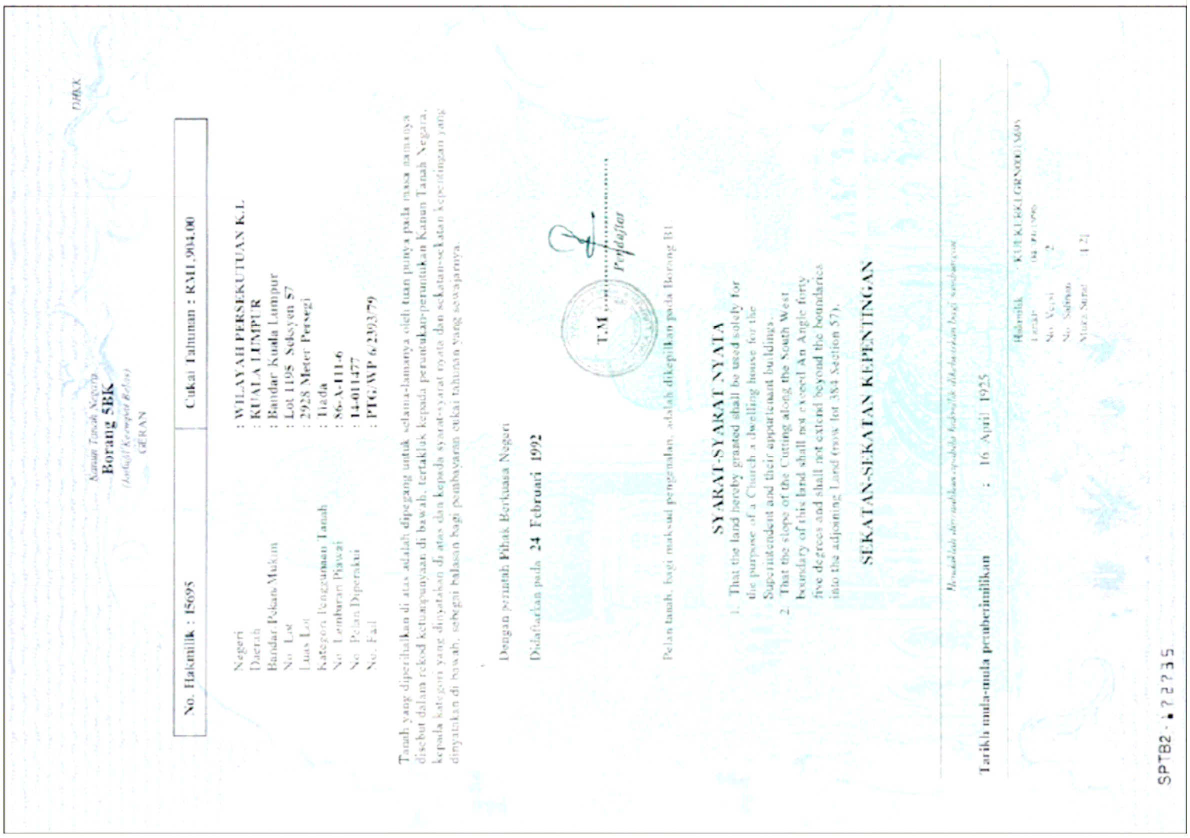
REKOD KETUANPUNYAAN

Ownership record: Name and address

REKOD URUSAN

PERKARA LAIN YANG MELIBATKAN HAKMILIK

T.M. .... Pendaftar


Kanun Tanah Negara
Borang 5BK
GERAN

No. Hakmilik : 15695	Cukai Tahunan : RM1,904.00

Negeri	: WILAYAH PERSEKUTUAN K.L
Daerah	: KUALA LUMPUR
Bandar/Pekan/Mukim	: Bandar Kuala Lumpur
No. Lot	: Lot 1198 Seksyen 57
Luas Lot	: 2928 Meter Persegi
Kategori Penggunaan Tanah	: Tiada
No. Lembaran Piawai	: 86-A-III-6
No. Pelan Diperakui	: 14-011477
No. Fail	: PTG/WP 6/2393/79

Tanah yang diperihalkan di atas adalah dipegang untuk selama-lamanya oleh tuan punya pada masa itu sebagaimana disebut dalam rekod ketuanpunyaan di bawah, tertakluk kepada peruntukan-peruntukan Kanun Tanah Negara, kepada kategori yang dinyatakan di atas dan kepada syarat-syarat nyata dan sekatan-sekatan kepentingan yang dinyatakan di bawah, sebagai balasan bagi pembayaran cukai tahunan yang sewajarnya.

Dengan perintah Pihak Berkuasa Negeri

Didaftarkan pada 24 Februari 1992

T.M. .... Pendaftar

Pelan tanah, bagi maksud pengenalan, adalah dikepilkan pada Borang B1

SYARAT-SYARAT NYATA

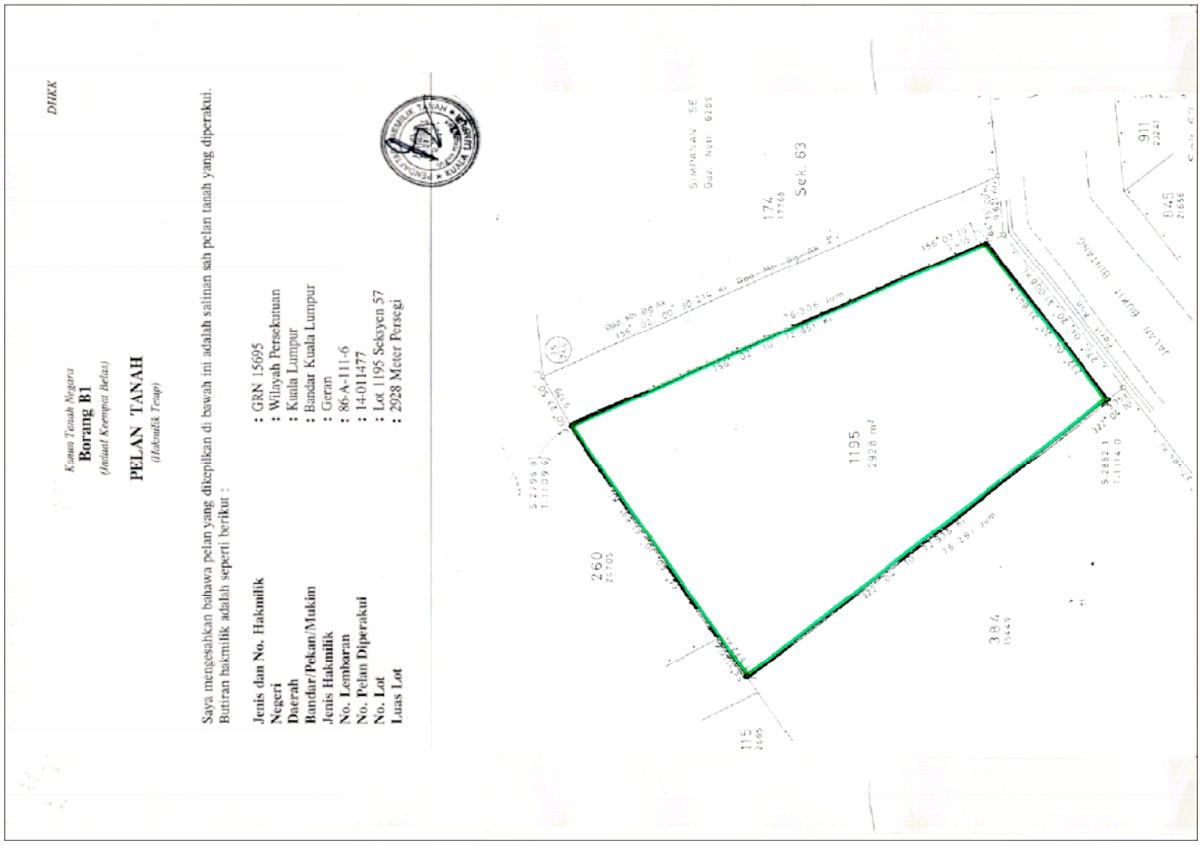
1. That the land hereby granted shall be used solely for the purpose of a Church a dwelling house for the Superintendent and their appurtenant buildings.
2. That the slope of the Cutting along the South West boundary of this land shall not exceed An Angle forty five degrees and shall not extend beyond the boundaries into the adjoining Land (now lot 384 Section 57).

SEKATAN-SEKATAN KEPENTINGAN

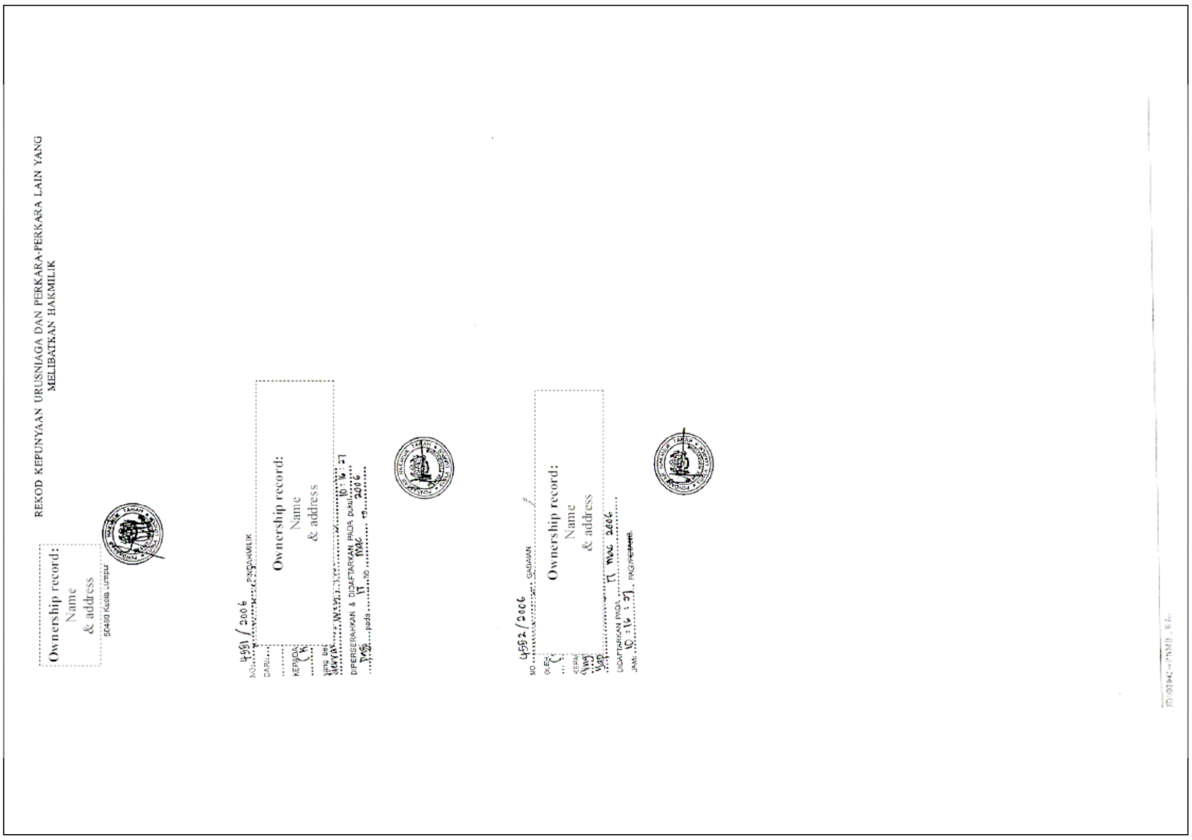
Tarikh mula-mula pemberimilikan : 16 April 1925

SPTB2 - 122735

Appendix C2: Malaysian document of title – page 3 (courtesy Mahyuddin & Siew)



Appendix C3: Malaysian strata document of title – page 1 & 2



REKOD KEPUNYAAN URUSNIAGA DAN PERKARA-PERKARA LAIN YANG MELIBATKAN HAKMILIK

Ownership record:
Name
& address

4591 / 2006 PINDAHMILIK

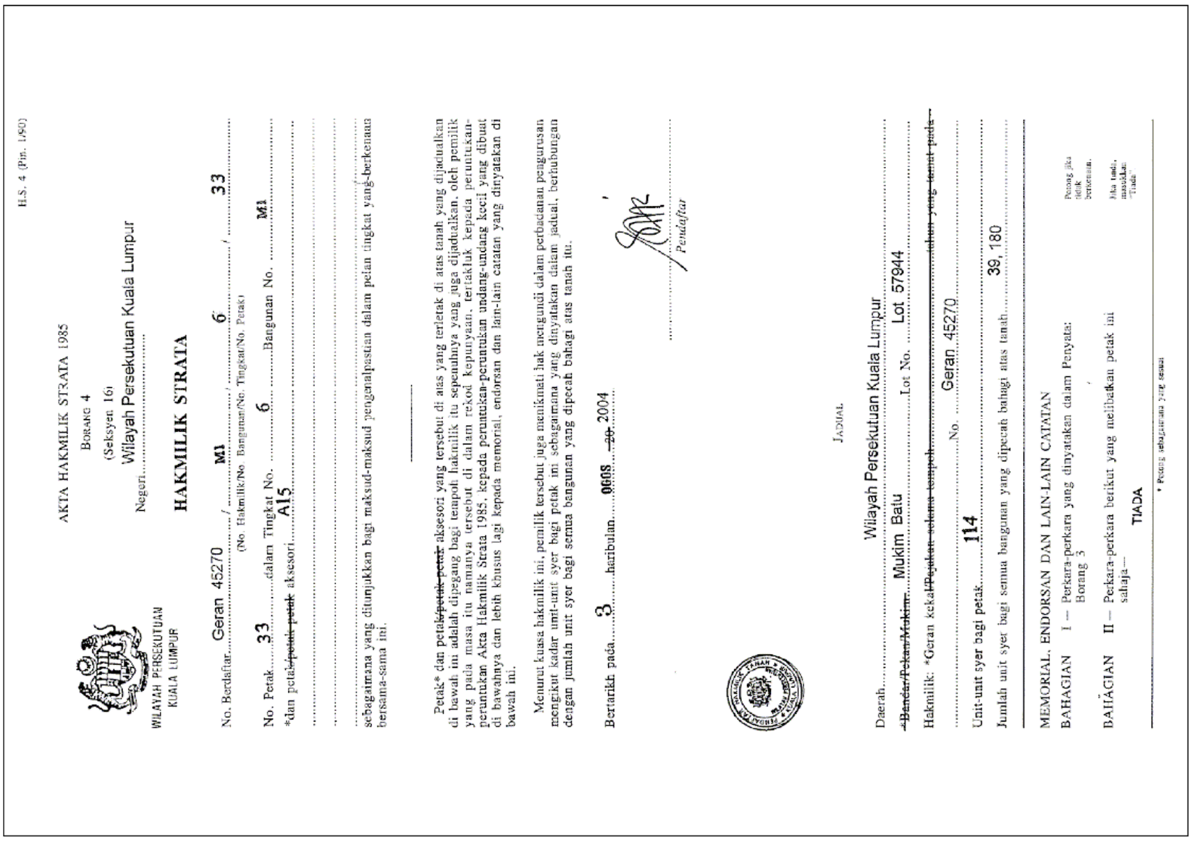
Ownership record:
Name
& address

DIPERSERAHKAN & DIDAFTARKAN PADA pukul 10 : 16 : 27 pada 17 MAC 2006

4592 / 2006 GADAIAN

Ownership record:
Name
& address

DIDAFTARKAN PADA 17 MAC 2006 JAM 10 : 16 : 27 PAGI/PETANG



H.S. 4 (Pin. 1/90)

AKTA HAKMILIK STRATA 1985

BORANG 4

(Seksyen 16)

Negeri Wilayah Persekutuan Kuala Lumpur

WILAYAH PERSEKUTUAN KUALA LUMPUR

HAKMILIK STRATA

No. Berdaftar Geran 45270 / M1 / 6 / 33

(No. Hakmilik/No. Bangunan/No. Tingkat/No. Petak)

No. Petak 33 dalam Tingkat No. 6 Bangunan No. M1

*dan petak ~~/petak-petak~~ aksesori A15

sebagaimana yang ditunjukkan bagi maksud-maksud pengenalpastian dalam pelan tingkat yang berkenaan bersama-sama ini.

Petak* dan petak ~~/petak-petak~~ aksesori yang tersebut di atas yang terletak di atas tanah yang dijadualkan di bawah ini adalah dipegang bagi tempoh hakmilik itu sepenuhnya yang juga dijadualkan, oleh pemilik yang pada masa itu namanya tersebut di dalam rekod kepunyaan, tertakluk kepada peruntukan-peruntukan Akta Hakmilik Strata 1985, kepada peruntukan-peruntukan undang-undang kecil yang dibuat di bawahnya dan lebih khusus lagi kepada memorial, endorsan dan lain-lain catatan yang dinyatakan di bawah ini.

Menurut kuasa hakmilik ini, pemilik tersebut juga menikmati hak mengundi dalam perbadanan pengurusan mengikut kadar unit-unit syer bagi petak ini sebagaimana yang dinyatakan dalam jadual, berhubungan dengan jumlah unit syer bagi semua bangunan yang dipecah bahagi atas tanah itu.

Bertarikh pada 3 haribulan OGOS ~~20~~ 2004

Pendaftar

JADUAL

Daerah Wilayah Persekutuan Kuala Lumpur

~~*Bandar/Pekan/Mukim~~ Mukim Batu Lot No. Lot 57944

Hakmilik: *Geran kekal ~~/Pajakan selama tempoh ... tahun yang tamat pada~~

No. Geran 45270

Unit-unit syer bagi petak 114

Jumlah unit syer bagi semua bangunan yang dipecah bahagi atas tanah 39,180

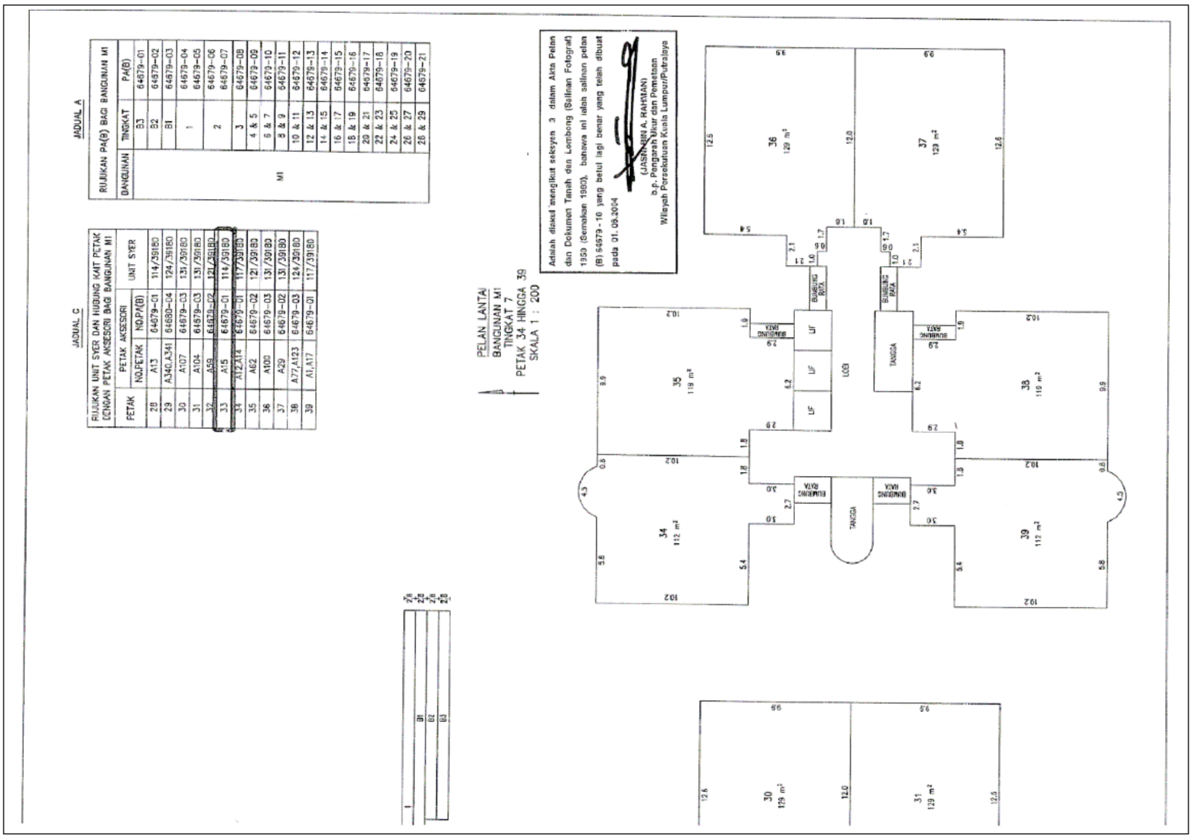
MEMORIAL, ENDORSAN DAN LAIN-LAIN CATATAN

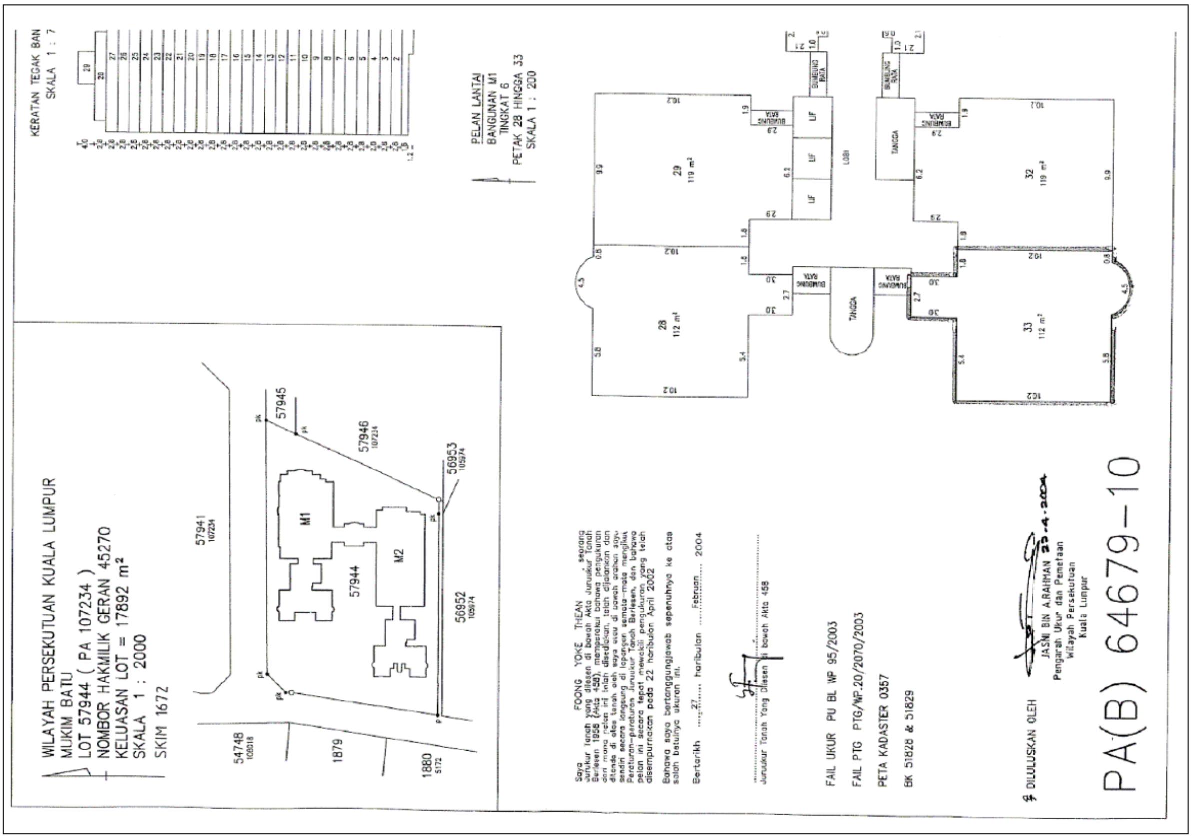
BAHAGIAN I — Perkara-perkara yang dinyatakan dalam Penyata: Borang 3 — Potong jika tidak berkenaan.

BAHAGIAN II — Perkara-perkara berikut yang melibatkan petak ini sahaja— TIADA — Jika tiada, masukkan "Tiada".

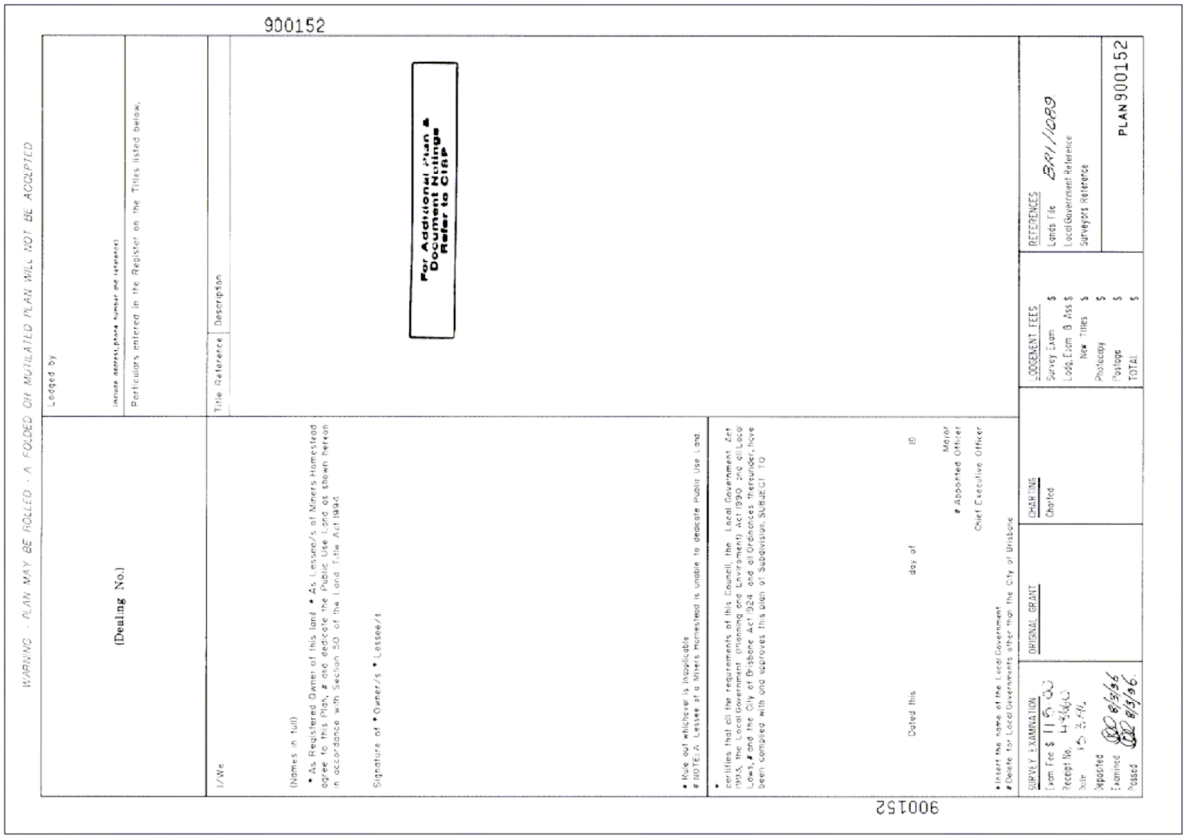
* Potong sebagaimana yang sesuai

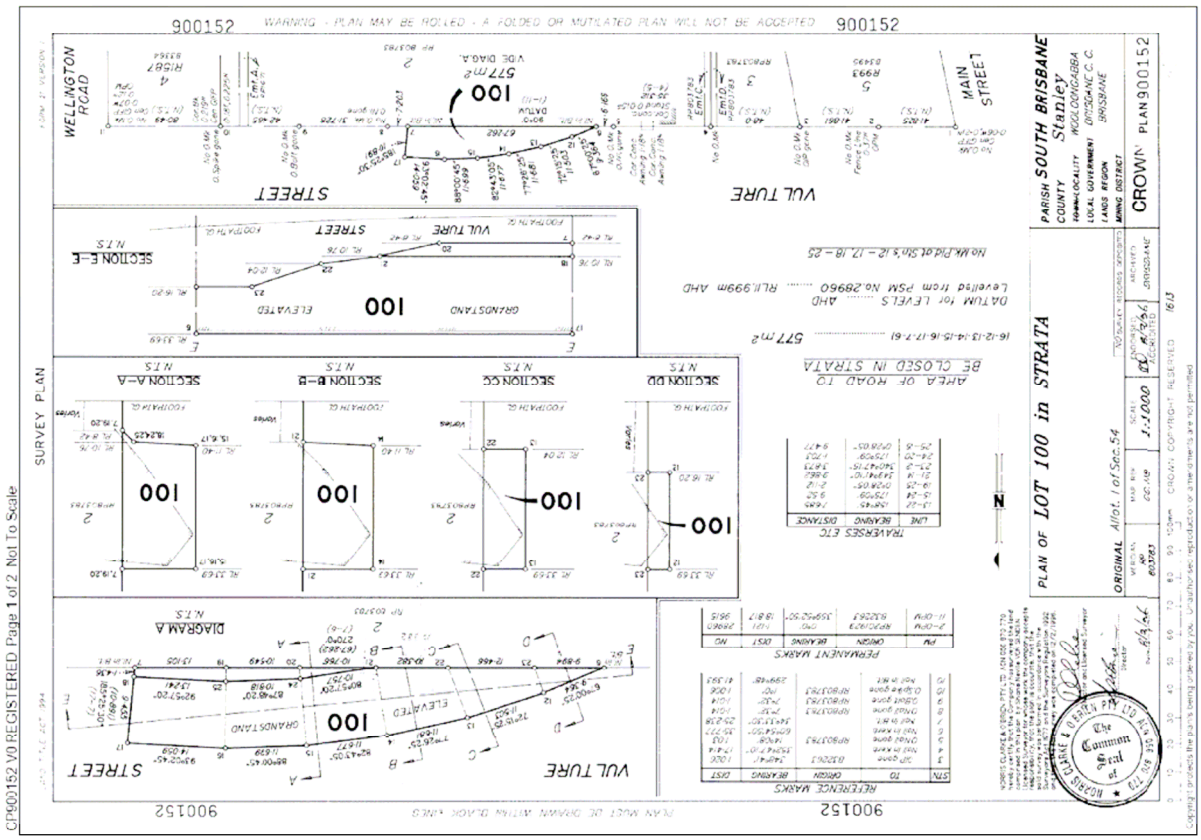
Appendix C4: Malaysian strata document of title – page 3 & 4





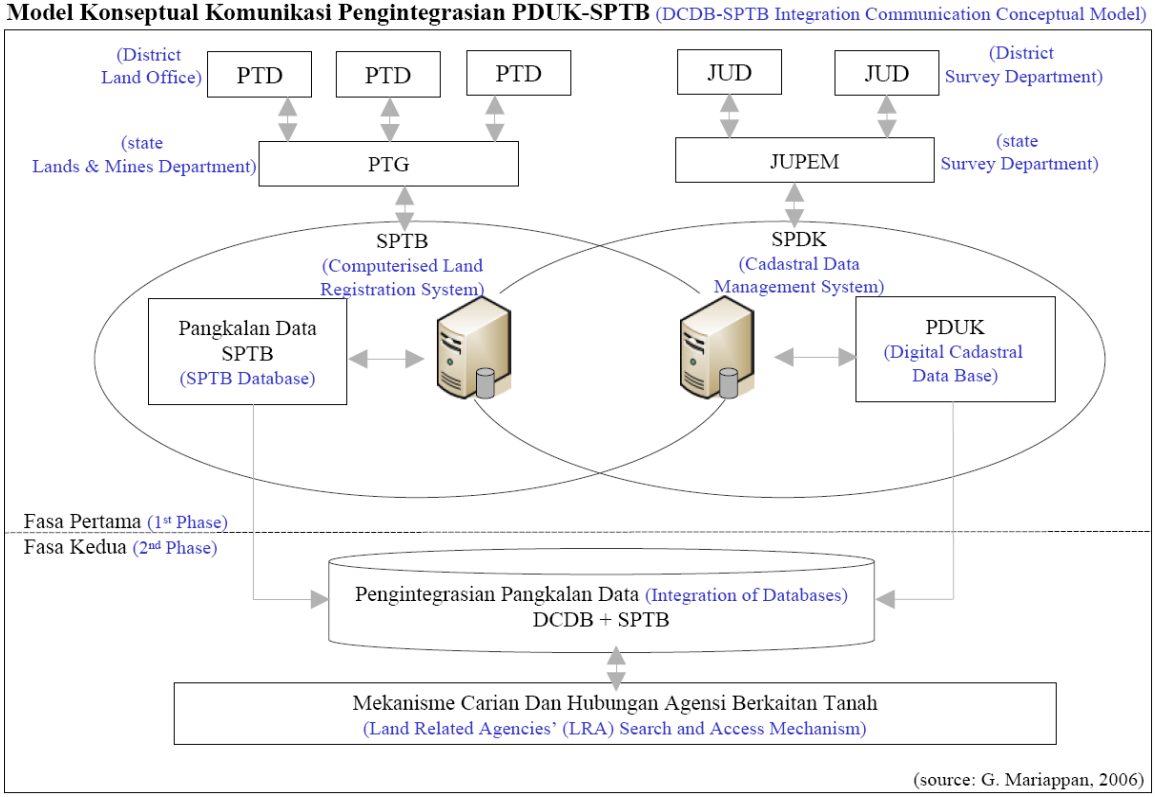
Appendix D: Queensland's survey plan for volumetric parcel (courtesy Rod Thompson)





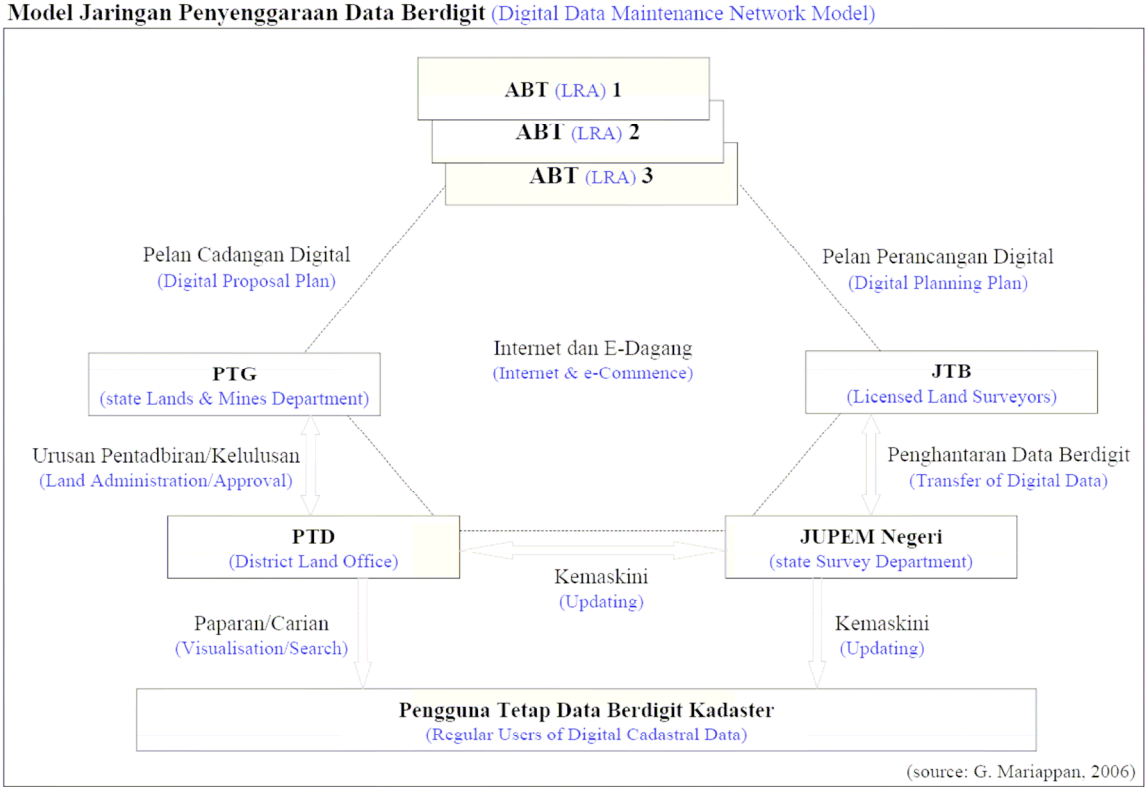
Appendix E: SPTB & DCDB Integration Conceptual Model and Maintenance Network Model (reproduced from G. Mariappan [23], with English translation in bracket)

Model Konseptual Komunikasi Pengintegrasian PDUK-SPTB (DCDB-SPTB Integration Communication Conceptual Model)



(source: G. Mariappan, 2006)

Model Jaringan Penyenggaraan Data Berdigit (Digital Data Maintenance Network Model)



(source: G. Mariappan, 2006)