Developing Infrastructure Framework to Facilitate the Malaysian Multipurpose 3D Cadastre

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Key words: land administration, land information, multipurpose 3D cadastre, National Digital Cadastral Database

SUMMARY

In the last couple of decades, there has been an increasing demand for property development in urban areas, resulting in the division of property ownership so that different owners can own a delimited space on, above or below ground surface. When multiple uses of space above surface was started by high rise constructions and aviation, it brought forth the question whether such space could be subdivided into separate units for individual ownership. Thus a situation has emerged where the dimensions above and below the ground surface, besides those on the ground, are important considerations in property ownership. Under 3D cadastre, the 2D cadastre management of data cannot meet the real land management of the three dimension space aspect and property. Therefore, it is essential to introduce the 3D cadastre of Three-Dimensional National Digital Cadastral Database (3D-NDCDB) management model. Since the individualisation of property has traditionally been concerned with the subdivision of land using on surface boundaries in the cadastral system, it is appropriate now to consider how three-dimensional situations should be handled from the legal, technical and organisational aspects, and how other countries have addressed similar issues. This paper solely concerned with the theoretical aspects of the study, particularly land administration system and cadastre system. It covers and explains the theory and framework of the Malaysian Cadastre System, good governance involved in land administration and cadastre. The present 2D National Digital Cadastral Database stored information in 2D planimetric. In order to achieve the objective, some of these matters must take into consideration, i.e. (a) Method of data collection, (b) Adjustment and calculation of observed data, (c) The products, and (d) Changes to the format and structure of existing system. In addition, the suitable Land Administration Domain Model base on 3D-NDCDB and some recommendations for amendments to the National Land Code 1965 as well as data information integration will be proposed.It is hoped that this study will provide a better understanding of the nature of 3D-NDCDB, besides adding new information to the available literature in the field. I envisage the main contributions of this study to the present knowledge to be in the cadastral survey and mapping, and land registration practices in the Malaysian Cadastre System from the legislative and technical viewpoints.

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1. INTRODUCTION

Multiple use of land is increasing. The owner of a parcel of land may possess the rights to the column of air above and the column of soil under that land. At ground level, multiple use of land has resulted in the multiple exercises of rights of the use of the regions above and below ground level and in the division of rights in the ownership column. The consideration which is studied in most countries for the achievement of an unambiguous determination of 3D cadastre issue starts gradually from the existing 2D cadastre system, leading to a better understanding of the legal, organisational and factual situations above and below the ground surface. Moreover, as mentioned by Aydin, Demir and Atasoy (2004), the use of three-dimensional data in applications to register properties, property rights of objects in geometrical and legal situations, parcel based three-dimensional information systems should be supported by three-dimensional information. Hence, legal and organisational aspects in the 3D cadastre system are preliminary to other aspects.

The first stage of this research involved the literature review on the characteristics of land administration and follow by a review of the land administration and cadastre systems in Malaysia. In second stage, a test project, where a trial implementation for the Three-Dimensional National Digital Cadastral Database (3D-NDCDB) which allows a mixture of 2D and 3D cadastre information was carrying out in State of Negeri Sembilan, Malaysia. This is to provide land with 3D elevation data. This addition information add to the boundary marks in the existing NDCDB would create a 3D-NDCDB. To achieve this purpose, the matters to be addressed are as (a) Field Data Acquisition (b) Adjustment and Calculation of Observed Data (c) 3D-NDCDB, and (4) Changes of Format and Structure. Later, the suitable Malaysian Land Administration Domain Model based on 3D-NDCDB and some recommendations for amendments to the National Land Code 1965 as well as data information integration will be proposed.

Malaysian land and cadastre registration is served by a transparent and accessible registration of rights to properties. Nevertheless, current cadastre system that is traditionally parcel-based experience complications in maintaining and providing information on the legal status of properties in three-dimensional situations. A 3D cadastre must cater for not only general, fundamental needs but also country specific needs. General needs address the issue on how to maintain and provide three-dimensional information on properties in land administration and cadastre systems, which are traditionally based on a plane surface cadastral map and registry title.

2. OBJECTIVES

The purpose of this paper is to examine the possibility of implementing 3D cadastre system in Malaysia. One of the important principles in the development of cadastre system is the fully 3D land information surface. This addition information to the boundary marks in the existing NDCDB would create a 3D-NDCDB.

The term 3D lot or 3D parcel is difficult to define because it lacks a universally accepted meaning. The concept of a 3D lot or 3D parcel may vary, depending on the legislation and the country where it is used. Since there is no clear and commonly accepted lexical definition of 3D 3D lot or 3D parcel, I try to keep it as comprehensive and general as possible to encompass different forms of 3D lot or 3D parcel. Thus, my definition of 3D 3D lot or 3D parcel is *LOT OR PARCEL WITH DIMENSIONS ON SURFACE AND DIMENSIONS ABOVE SURFACE AND/OR DIMENSIONS BELOW SURFACE THAT IS IN SEPARATE (INDEPENDENT) TITLES.*

3. LITERATURE REVIEW

Historically, there have been four processes or components in land administration, namely land registration, land valuation, land use planning and cadastral survey and mapping.

3.1 Land Administration System

The term 'land administration', introduced in the 1990's, probably became more widely used after the United Nations Economic Commission for Europe in 1996 formed an ad hoc group of experts known as the 'Meeting of Officials in Land Administration' (United Nations Economic Commission for Europe, 1996). Dale and McLaughlin (1999) add that State land administration functions may be divided into four components, namely juridical component, regulatory component, fiscal component and information management component. Land administration is concerned with three principals and interdependent commodities, viz. ownership, value and use of land. In short, land administration systems are the basis of conceptualising rights, restrictions and responsibilities related to people, policies and places in support of sustainability as well as land and property.

3.2 Land Information System

The declaration by the FIG highlights the importance of the cadastre as a land information system for social and economic development. It offers an international perspective of the cadastre as a land information system for social and economic development. There are three categories of cadastre, namely the juridical cadastre; the fiscal cadastre; and the multipurpose cadastre (Dale, 1976; Dale and McLaughlin, 1988).

3.3 Cadastre System

Cadastre systems include the interaction between the identification of land parcels, the registration of land rights, the valuation and taxation of land and property, and the present and possible future land use (Enemark, 2005). Therefore, it is noted that even though cadastre systems around the world are clearly different in terms of structure, processes and actors, their design is increasingly influenced by globalisation and technology, moving towards multipurpose cadastres (Molen, 2003). The cadastre system comprises the map, real estate and land register. The map shows the boundaries of real estates and location of the parcels. The land register based on the cadastre contains a list of titles for real estate. Today's cadastre registration not only focuses on property registration but also serves other tasks used by private and public sectors in land development, urban planning, land management and environment monitoring (Federation Internationale de Geometres, 1995; Williamson and Ting, 2001).

Cadastres and cadastral surveys are aspects of land administration. The primary object of a cadastral is to determine for each land parcel, its location, the extent of its boundaries and surface area, and to indicate its separate identity, both graphically on a map or in a record as well as physically on the ground. Its secondary objective is to provide information for a multipurpose cadastre to fulfil the overall information requirements of land administration (Dale, 1976). The need to indicate boundaries on the ground came long before the practice of title registration, survey, mapping, or conveyancing (Simpson, 1976). In a legal sense, a boundary is a surface which defines where one landowner's property ends and the next begins. Normally, this surface is vertical and intersects the ground along the legal boundary line (United Nations Economic Commission for Europe, 2005).

4. THE IMPORTANCE OF 3D CADASTRE

Current cadastre registration systems, bound to ground surface topological and geometrically described parcels, have shown limitations in providing an insight into three-dimensional location of three-dimensional constructions as well the vertical dimension (depth and height) of rights established for three-dimensional constructions (Stoter, 2004). In addition, the cadastre should be able to describe property ownership, including Strata Title ownership. A 3D cadastre is defined as a cadastre that registers and gives insight into rights and restrictions not only on parcels, but also on 3D property units (Stoter, 2004). Thus, a 3D cadastre would be able to handle such conditions as overlapped buildings and utilities that prohibit the property from being registered according to legal and organisational aspects using a 2D cadastre.

In the near future, the cadastre will contain updated documentation of public and private rights, ownership, land use and real estate in various spaces. Concurrently, Benhanu and Doytsher (2003) contend that the 3D boundaries and parcels in space will be determined by the 3D cadastre that serves the legal and physical objectives. A modern cadastre system should always reflect the existing situation of all property rights, including a mixture of private and public properties. It should provide a better-rationalised management of the built environment, including regulations of legality of use or of economic application (Dimopoulou, Gavanas and Zentelis, 2006).

Rapid urban development today is increasing the demand for three-dimensional boundaries to support the volume parcels in real property objects. However, problems may arise from the registration of 3D properties. Stoter (2004) proposes three fundamental concepts (full 3D cadastre, 2D/3D hybrid cadastre and 2D cadastre with 3D tags) to cater to and resolve such problems, albeit with minor modifications to suit or match the cadastral survey, mapping registration system and land registration system to that of each country.

5. MALAYSIAN LAND ADMINISTRATION

Before British rule was established in Penang and Melaka, the customary land tenure followed the same pattern as in Sarawak, Borneo, Burma and parts of India and Ceylon. When the British took over the administration of Penang, it was virtually an uninhabited island with no settled law, much less a recognised land system (Tan, Liat Choon, 2013). The early English Law that was introduced into Penang was known as the Deeds System, which recorded land transactions in the form of deeds or indentures. According to Das (1963), the Deeds System was introduced in Penang properly as early as 1807 and in Singapore in 1819, and later extended to Malacca in 1826.

5.1 Cadastre System

Malaysian land administration is traditionally based on Malaysian land law, while the Malaysian cadastre system has essentially two basic components, namely land registration and the cadastral survey and mapping that have different structures and authorisations. The traditional cadastre system that is practised in Peninsular Malaysia is a parcel bound system and provides essential land and property information of the lots and land parcels. The existing Malaysian cadastral survey and mapping registration system and land registration system deal with properties located not only on the surface level, but also above and below the surface level. Therefore, the rights of the proprietor of the surface parcel shall also apply to the air space above and the space underground as well.

The Malaysian land registration system provides for textual and spatial information that is consistent with the two aforementioned components of the system. Although not strictly part of the cadastral survey system, valuation, local government and planning authorities are heavily reliant on the land registration system. They utilise the information provided by the system in conducting their business, and work in close coordination with the institutions supporting the system. Meanwhile, the Malaysian cadastral survey and mapping system is based on the Cassini Solder Coordinate System. Each State has its own origin and reference meridian. Cadastral maps are used primarily for the identification of land parcels for the purpose of land management. All the lots that are surveyed by both government and licensed land surveyors are plotted on the maps. All States currently have cadastral maps in digital form based on a graphical representation of geometric components.

There are two types of boundary in Malaysian statute. First, boundary for land; land boundaries are identified by boundary marks (see Figure 1). Second, boundary for parcel; parcel boundaries are identified by party wall (see Figure 2). Under the Torrens System, the boundaries of each surveyed land parcel are defined by coordinates, bearings and distances. Lots can be defined either by physical demarcation or described mathematically based on a coordinate system. Lots and other information are shown in a cadastral map which provides information for identification of land or building parcels for survey and land administration.

The description of parcel boundaries and cadastral survey data are shown as graphical information. It commences with preparation of the survey plan which is then submitted for authentication by the Department of Survey and Mapping Malaysia.

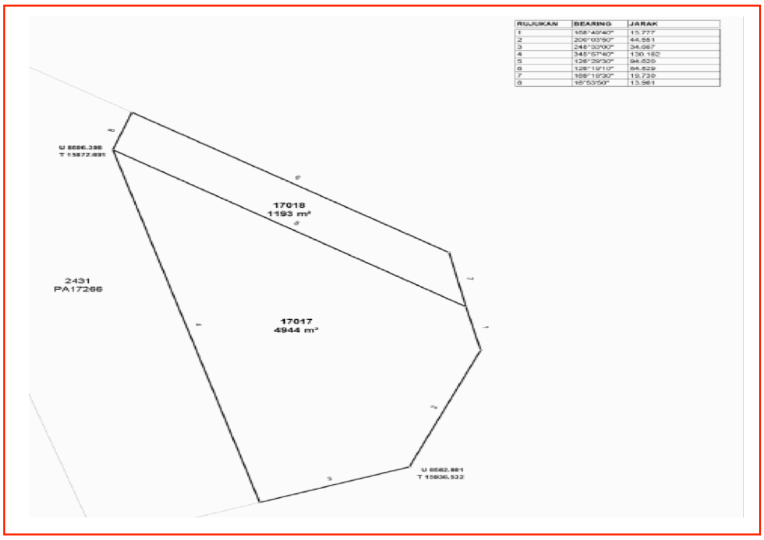

Figure 1: Boundary for land

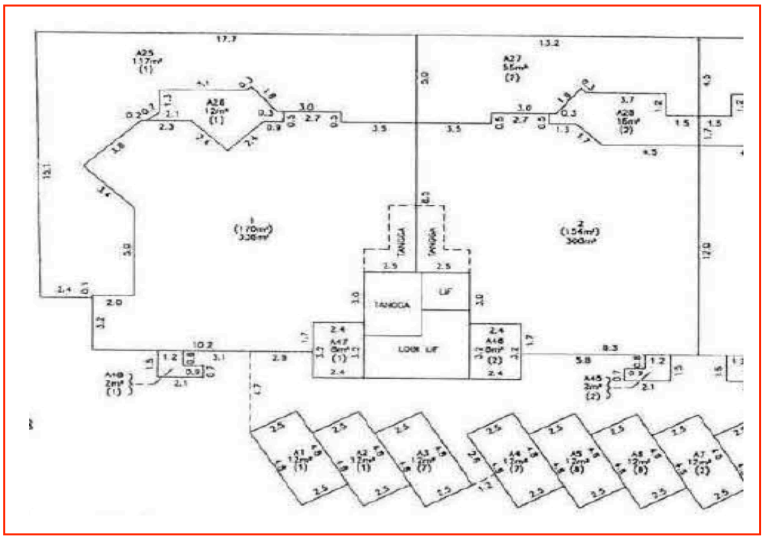

Figure 1: Boundary for parcel

5.2 eCadastre

The primary objective of eCadastre is to expedite the delivery system for land title surveys. This entails the creation of a survey accurate database at the national level suitable for Geographical Information Systems (GIS) users. Various issues related to the generation of a survey accurate database need to be addressed. The vision of Malaysia becoming a developed country by 2020 calls for the realisation of an efficient public delivery system at various levels. Among the issues of national interest are land related matters, which include cadastral surveys. The government approved an eCadastre project under the 9th Malaysian Development Plan (2006-2010) to be implemented by the Department of Survey and Mapping Malaysia (DSMM), in line with the government's aspiration to have a fully digital Malaysia by 2015.

Since 1995, DSMM has embarked on a modernisation program that saw the dramatic computerisation of both its office and field processes of its cadastral survey division. The Digital Cadastral Database was created by capturing the surveyed accurate information of all land parcels. Under the eCadastre project, a comprehensive nationwide readjustment of the meshwork of parcels will be carried out based on a new geocentric datum concept. The Real Time Kinematic Global Positioning System (RTKGPS) has seen the setting up of permanent stations established to provide precise geocentric positioning to assist the Coordinated Cadastral System implementation. This network is to be implemented to support the eCadastre project.

The current system of cadastral survey is yet unable to capitalise on the advent of satellite based technologies. A complete revamp of the system is required before any improvement to the delivery system could be achieved. The new environment will allow various cadastral survey processes, such as planning, layout design submission, field data capture, completed job submission, quality control and approval, to be carried out remotely via the mobile telecommunication network. Global Positioning System (GPS) will provide real time positioning at centimetre resolution homogeneously for the entire country and coordinates will replace relative measurements as the ultimate proof of boundary mark position. Additional features such as building footprint and space images will be incorporated into the new database in a move towards a multipurpose cadastre.

There are three main components in eCadastre, namely Coordinated Cadastral System, Virtual Survey System and Cadastral Data Integrity System. The implementation of a Coordinated Cadastral System is a major part of the eCadastre project that includes field and office reengineering to reduce processes and increase the use of digital technology. The Virtual Survey System will equip the field surveyor with ICT, total station, GIS and GPS. The surveyor will be able to interact with the system to extract information that is essential in field operations. Most of the work is automated to reduce tedious computation.

Meanwhile, Cadastral Data Integrity System comprises all the office application related to cadastre, which include pre-survey verification, field survey data computation and verification, digital title plans generation and approval. In order to implement multipurpose 3D cadastre in Malaysia, new requirements are needed to capture the data in three-dimensional (on surface, above surface and below surface) to cater for strata, stratum surface.

5.3 eLand

To realise computerisation of the overall management and administration of land in the country, the Ministry of Natural Resources and Environment (NRE) planned to create an integrated computerised system, known as the Electronic Land Administration System (eLand). ELand is designed to improve the delivery of land administration and management services in Peninsular Malaysia using an integrated ICT infrastructure. Currently, the Ministry of National Resources and Environment has implemented two systems for the administration of land information, namely *Sistem Pungutan Hasil Tanah* (SPHT) and *Sistem Pendaftaran Tanah Berkomputer* (SPTB). Both systems are already being used in all State Land and Mines Office and District Land office in Peninsular Malaysia.

ELand is an integrated and a fully computerised system to handle the management and administration of Land Offices in order to improve the speed and quality of service delivery to the public for all land related transactions. ELand enables the public to make payments online and print the payment receipts, checking details on their own land and so on. The business processes supported by eLand maximizes the utilisation of the existing ICT infrastructure, taking into account the existing processes and procedures. The new system will be merged and integrated with the existing systems.

The objective of eLand is to develop a comprehensive system in land offices in order to modernise all activities that are related to land and to realise the implementation of electronic government in the public sector. The achievement of an updated, effective, and accurate National Land Administration System via ICT is eLand's vision. In addition, eLand's mission is to develop and implement a National Land Administration System via ICT towards enhancing the growth of national development.

6. TOWARDS MULTIPURPOSE 3D CADASTRE IN MALAYSIA

The current Malaysian cadastral survey and mapping system needed more sufficient three-dimensional objects registration rights for certain overlapping properties. The two-dimensional type of cadastral system, which has been practised in Malaysia for a period of one hundred years, provides essential information about ownerships of lots and land parcels for the country. The eCadastre and eLand, which work separately in each organisation with different legal aspects, are still in a two-dimensional plane surface. Furthermore, there is a need in three-dimensional objects for taxation and land use to be linked together.

There could be extensive benefits if the eLand, the eCadastre, the taxation data from the Valuation and Property Management Department and land use from the Town Planning and Development Department are linked together. With the integration of attribute data from eLand and spatial data from eCadastre and through identified applications, the efficiency of land administration can be greatly improved. Nordin (2001) stated that the envisaged applications include on-line registration for surveys and preparation of titles, extending the Digital Cadastral Database enquiry module to the land administrators and also linking the Qualified Title information to the Digital Cadastral Database. Although conceptually tenable, the eventual implementation would need substantial negotiation and compromise among land offices and survey department.

In recent years, a 3D cadastre registration system is being developed. Researchers have contemplated adding 3D cadastre objects in the current cadastre data model and information, accessible by the Department of Survey and Mapping Malaysia, State Land and Mines Office, and District Land Office. Unfortunately, the two stated databases, *viz.* the eCadastre and the eLand database work separately under different authorities, need to support three-dimensional.

A multipurpose 3D cadastre can be defined as an integrated land information system containing legal (e.g. tenure and ownership), planning (e.g. land use zoning), revenue (e.g. land value, assessment and premium) and physical (e.g. cadastre) information. Therefore, the Malaysian multipurpose 3D cadastre should contain all information about administrative records, tenure, value and sale & purchases records, base maps, cadastral and survey boundaries, categories of land use, streets addresses, census utilities etc. It has the potential to support spatial enabled government, private sectors and society by expanding the process of visualisation, organisation and management of useful land information.

7. CASE STUDY

At present, the digitalisation has fully implemented in the department and is better known as National Digital Cadastral Database (NDCDB). NDCDB adopted now is a database of two-dimensional (2D) (*x, y*), where the information is stored in 2D coordinate planimetric. To produce 3D (*x, y, h*) for each boundaries mark, methods of data collection, calculation and adjustment of traverse survey data need to be changed. One of the important principles in the development of cadastral system is the fully 3D information of land surface (Tan, Liat Choon and Looi, Kam Seng, 2013a).

This subsection will discuss a trial implementation for the Three-Dimensional National Digital Cadastral Database (3D-NDCDB) which allows a mixture of 2D and 3D cadastre information. To begin, the aim is to provide land with 3D elevation data. This addition information add to the boundary marks in the NDCDB would create a 3D-NDCDB. To achieve this purpose, the matters to be addressed are as (a) Field Data Acquisition (b) Adjustment and Calculation of Observed Data (c) 3D-NDCDB, and (4) Changes of Format and Structure. For the purpose, a test project was carrying out in State of Negeri Sembilan, Malaysia.

7.1 Field Data Acquisition

The collection of traverse data in the field in eCadastre environment is fully digitalised. The current method of data collection is using Digital Field Book (BKD) interface. There are two main components of BKD, i.e. observation bearings and distances. Final bearing is produced from the Least Square Adjustment (LSA). Data collection to produce 3D coordinates requires additional information tools, i.e. observation of height of Total Station and prism. With this additional information, existing BKD must be changed to suit those needs. In the existing BKD, the terms of observations is “vertical angle”, while the observations recorded are zenith angle values. To implement 3D cadastre, the use of vertical angle observations are more practical, which the surveyor can calculated the high difference in positive or negative value.

7.2 Adjustment and Calculation of Observed Data

Least Square Adjustment (LSA) in the cadastral survey in Malaysia has been fully utilized in eCadastre environment. However, the adjustment only involves 2D data. To produce 3D-NDCDB, an adjustment with 3D data should be done. For this purpose, the observed data used and exported to an adjustment format are bearings, distances and high differences information. Coordinates (x, y, h) reference adopted in the formation of 3D-NDCDB must be compatible with the coordinate system used by eCadastre and MyGEOID. This compatibility is important that the height of product for each traverse boundaries have height information. For this purpose, the start station must have a value of orthometric height to allow the determination of orthometric height of the front station.

7.3 3D-NDCDB

The 3D-NDCDB products will be the basis of fully 3D cadastre implementation. Among the 3D-NDCDB initial products are as follow:

7.3.1 <u>Height Information</u>

Height information of each boundary mark (see Figure 3).

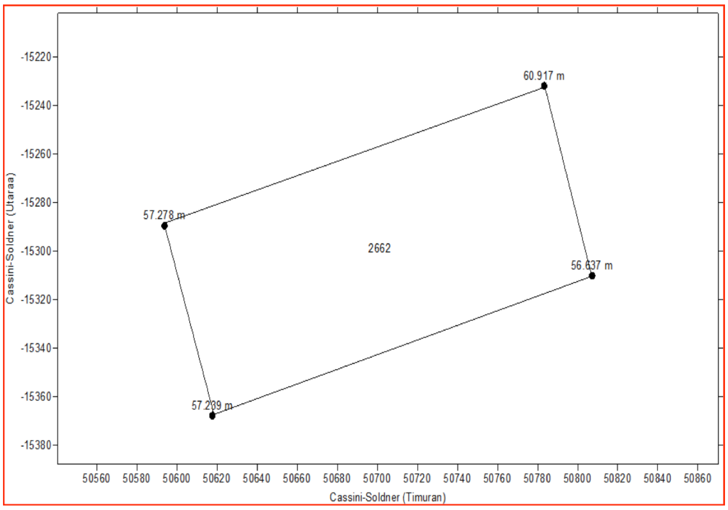

Figure 3: Example of height information

7.3.2 3D Certified Plan (3D-PA)

i) Contour information for each lot (see Figure 4)

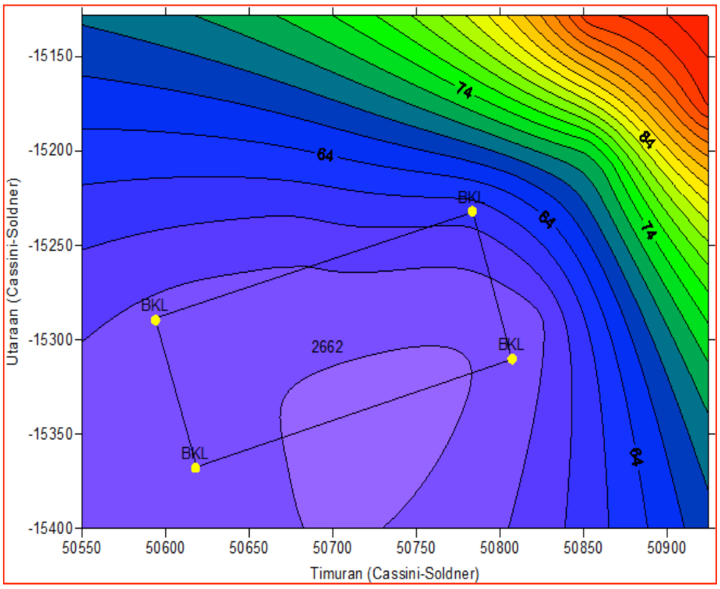

Figure 4: PA with contour lines

ii) 3D plot (see Figure 5)

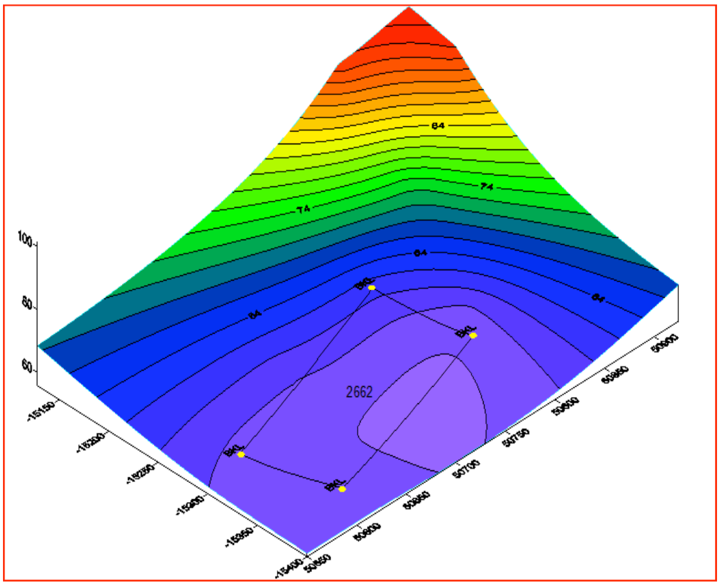

Figure 5: PA with 3D plot

iii) 3D wireframe plot (see Figure 6)

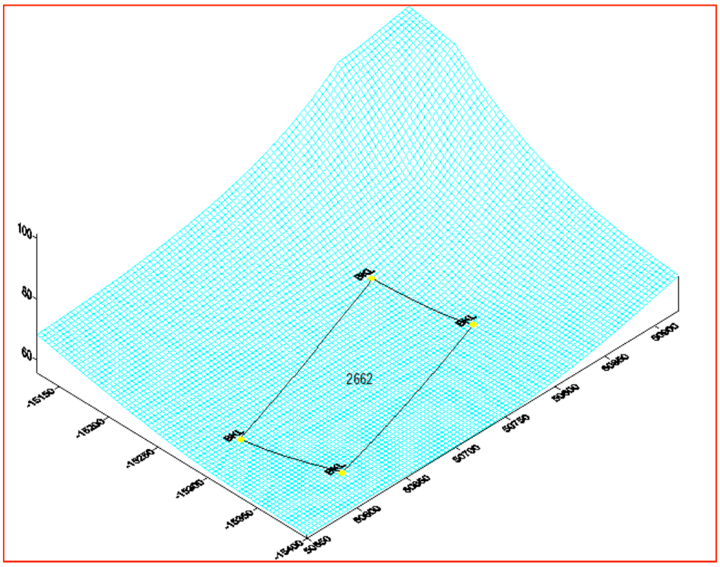

Figure 6: PA with 3D wireframe plot

7.3.3 Certified Plan (PA) with Satellite Image

Overlay plot with satellite imagery for surface analysis for landslide studies and consolidation of information from LIDAR or IFSAR grid (see Figure 7).

Figure 7: PA with Satellite Images

7.3.4 Digital Terrain Model (DTM)

Produce Digital Terrain Model (DTM), which is more accurate for use in the field of geodesy (see Figure 8).

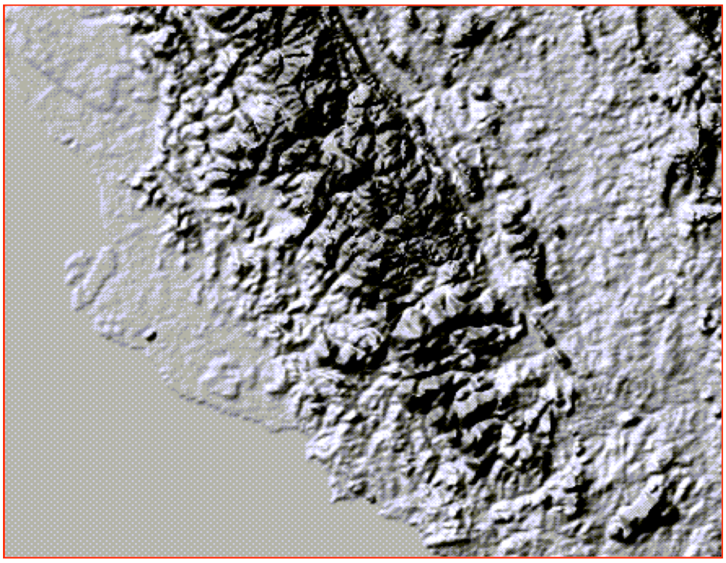

Figure 8: Improvement DTM

7.4 Changes Of Format And Structure

Owing to the additional information collected, format and structure of the existing system should be changed and make available to meet these needs. Later, the amendments should emphasize on (a) Procedures in Survey and Mapping Director General Secular, (b) Output structure of the data collection, (c) Adjustment methodology and data processing, (d) Existing NDCDB Structure , and (e) Existing eCadastre application (Tan, Liat Choon and Looi, Kam Seng, 2013a).

7.4.1 Procedures in Survey and Mapping Director General Secular

Procedures and guidelines should be amended to accommodate these needs in the field which emphases the following:

a) Start station should have an orthometric height
b) To record the height of instrument and height of prism
c) To read vertical angle instead of zenith
d) To record temperature readings
e) To calibrate the Total Station
f) To calibrate the Tribrach
g) To amend the weights used in LSA
h) To use Differential Field Test (DFT) for the observed vertical angle
i) The limit in the dispute of height value
j) The method of taking offsets and offset features
k) The display of the products

7.4.2 Output structure of the data collection

The format and structure of the existing output for data collection by using Total Station and GNSS should also be transferred. The amendments involved include the following:

a) File FBK For 16 ASCII
b) File TPS For 16 ASCII
c) COO File for 16 ASCII
d) TPO File for 16 ASCII
e) POT File for GNSS observations

7.4.3 Adjustment methodology and data processing

Processing and data adjustment methodology adopted should also be reviewed as appropriate. Among the aspects that should be addressed are as follows:

a) Data adjustments in Adjustment LSA
b) Methodology Fixed Points for Adjustment LSA
c) Value Adjustment Weights for LSA

7.4.4 Existing NDCDB Structure

The existing NDCDB structure is being designed to accommodate the height orthometric to development the 3D-NDCDB. Elevation information should be stored in the NDCDB STONE layer.

7.4.5 Existing eCadastre application

The existing eCadastre applications and Oracle databases should be reviewed to meet these requirements. Among those are:

a) eTSM (Title Survey Module)
b) eCRM (Cadastral Reference Marks)
c) SUM (Virtual Survey System)
d) EQC (Quality Assurance)
e) ESSM (Strata/Stratum/Marine)
f) DRP (Digital Raster Plan);
g) eGLMS (GIS Layer Management System)
h) Oracle Database

8. PROPOSED MALAYSIAN LAND ADMINISTRATION DOMAIN MODEL

Under the Torrens System, the boundaries of each surveyed land parcel are defined by coordinates, bearings and distances. Lots can be defined either by physical demarcation or described mathematically based on a coordinate system. Lots and other information are shown in a cadastral map which provides information for identification of land or building parcels for survey and land administration. The description of parcel boundaries and cadastral survey data are shown as graphical information. It commences with preparation of the survey plan which is then submitted for authentication by the Department of Survey and Mapping Malaysia. However, the cadastral map or Digital Cadastral Database (DCDB) is only two-dimensional in nature (Tan, Liat Choon and Looi, Kam Seng, 2013b).

According to Abdul Rahman et al. (2011), the State Land Offices and Department of Survey and Mapping Malaysia may follow ISO TC211 models of Land Administration Domain Model (LADM). These models have been used as a platform to suit with the Malaysian cadastre system. This approach means preservation of 2D cadastre and the integration of the 3D registration by registering 3D situations, integrated and being part of the 2D cadastral geospatial data.

The 2D/3D hybrid cadastre (Stoter, 2004) can be used for the implementation of 3D cadastre in Malaysia. The concept of hybrid cadastre is to preserve the current 2D registration and add the 3D component in the registration system. An integrated 3D cadastre model looks on how to add 3D component in the current cadastre data model (3D cadastre objects on the 2D land parcel), which is the responsibility of Department of Survey and Mapping Malaysia (DSMM). Adapting LADM, the 3D spatial database being design to make it interoperable with the current land registration database (Abdul Rahman et al., 2011).

Adaptation of LADM into integrated 3D cadastre model for Malaysia as illustrated in Figure 9. It is clearly defined that the LA_Party (owner) and the LA_RRR (right, restriction, responsibility) are under responsibility of the State Land Office while the LA_SpatialUnit (spatial data) are under responsibility of DSMM. The integration between these two databases is made on the linkage of LA_SpatialUnit and the LA_RRR in the integrated 3D Cadastre model for Malaysia. In this model, both LandParcel and 3DParcel are registered as an object in current registration system (Abdul Rahman et al., 2011).

The LandParcel is represented as a 2D geometry (bearing and distance). This object is inherited from the current 2D registration system. Figure 10 shows the data model of land parcel as a registered object. LandParcel i.e. cadastral lot consists of boundary lines and boundary marks. 3DParcel is formed with 2D geometry and 3D information. The 3DParcel is projected with the 3D bounded space with list of coordinate that form flat faces and later form a 3D object which so called 3D cadastre object (Abdul Rahman et al., 2011).

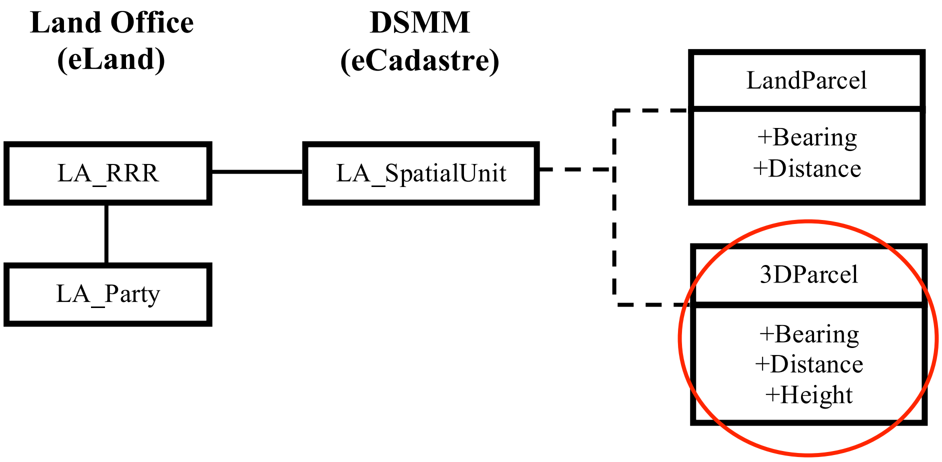

Figure 9: Adaption of LADM into 3D Cadastre Model

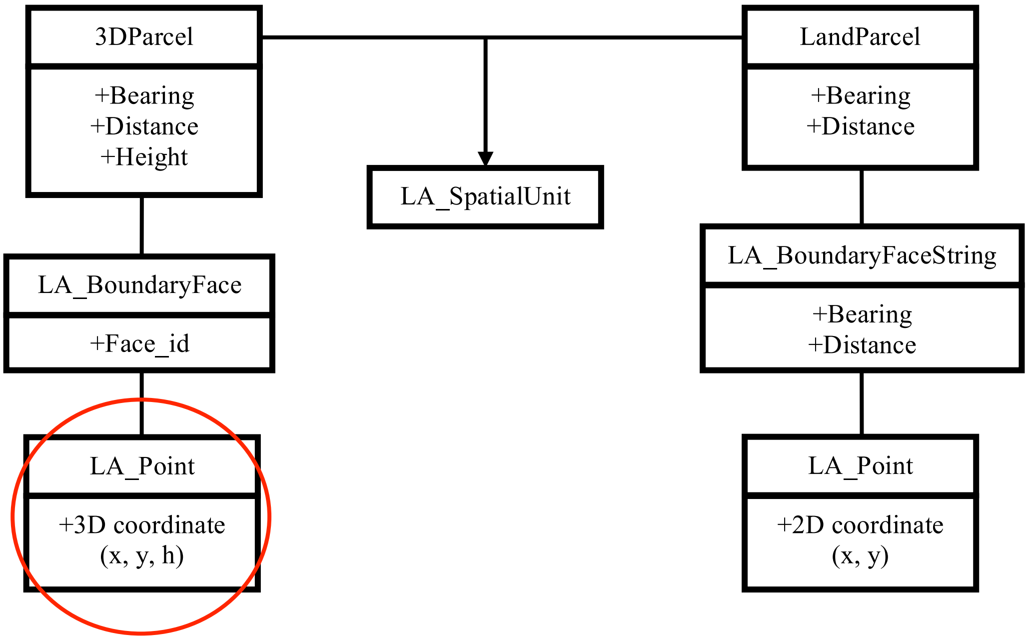

Figure 10: The data model for LandParcel and 3DParcel as LA_SpatialUnit

9. RECOMMENDATIONS FOR AMENDMENTS TO NATIONAL LAND CODE 1965

In order to ensure a clearer and more comprehensive legal framework for tenure and registration as well as delineation of 3D cadastre, the legislation needs to be amended where necessary. It is vital to make provisions for defining complicated building structures, especially those that include underground space and airspace that may qualify for separate (independent) titles.

It is suggested that the State authority may alienate separate title (independent) to a property above ground surface by giving limited right or without right to the surface. Airspace includes the dimension above the ground surface for three-dimensional properties. Section 75A needs to be amended so that the State could alienate airspace to a different owner for a period of 99 years. For 3D parcel above surface that do not have entrance access from the ground surface, and that has limited right to ground, it is suggested that an easement should be imposed on such properties from ground on State/private alienated land. Therefore, Part Seventeen (Easement) of the Code should be amended by adding a new section on easement from the adjacent building to a 3D parcel above surface. Though there is an issue with sections 92B and 92D, this could be resolved by issuance of guidelines regarding new titles that, for new titles, the depth of all subsurface properties should be specified so that independent titles could be registered. Lastly, Part Twenty-Nine of the code, in Section 396, describes the manner in which land surveys are to be carried out. This subsection should be amended by adding a description on how the 3D parcel boundaries located on surface and above surface can be demarcated on those surfaces.

10. TOWARDS DATA INFORMATION INTEGRATION

Land administration should ideally be under the supervision of a single authority that acts as the lead agency. Such an arrangement will guarantee the best possible coordination between the various parts of the whole process and provide the necessary framework for establishing a unified land information system and service. This ideal principle hope to exist in Malaysia.

The development of a multipurpose cadastre information system requires the contribution of many different departments to execute the fundamental components of the system. The implementation of each component is carried out by specific institutions at national, regional, and local level. The multipurpose cadastre provides not only land ownerships and property information but also a variety of land information such as land use, land zoning, infrastructure information, buildings, properties, and addresses. The new multipurpose cadastre enables systematic registration progressively and will overcome weaknesses of the old system such as the delay in updating registers, high registration costs, and absence of an exhaustive overview of existing parcels and properties within an area.

The new system could aim for support land planning, land administration, land taxation, and cadastre. For dissemination purposes, even hyperlinks from the cadastre or its spatial indexes to the data files of land-use planning authorities may be sufficient. However, the multiplicity of organisational and legal relations stresses the importance of structure information and in making information more widely accessible. Efficient data exchange must be focussed on data modelling, standardisation and an appropriate use of the common spatial reference framework.

There could be wide-ranging benefits if the data information in the Certified Plan from Department of Survey & Mapping Malaysia (DSMM), Registry Title and Land Office Title from State Land & Mines Office (PTG) and District Land Office (PTD), taxation from Valuation & Property Management Department, and category of land use from Town Planning & Development Department are linked together. Furthermore, the integration of the spatial database with the textual database is the prerequisite requirement for the creation of an inclusive land information system, ranging from the town level till the national level. Therefore, with the integration of these data information from various departments and agencies which are responsible for the cadastral survey, title registration, taxation and land use and through the unique parcel identifier that is assigned, the effectiveness of land administration system, land registration system, land information system and cadastre system can be significantly improved.

The multipurpose cadastre should be designed to record, store and provide not only land-tenure and land valuation information but also a wide variety of land-related facts. It does not only receive information and data from many sources, but it also provides services and products for many purposes and to many users. Therefore, in many ways, the multipurpose cadastre is designed to address the inherent problems in the geospatial industry by providing comprehensive records of land-related information and presenting this information at the parcel level. The figure below shows the fundamental framework of a multipurpose cadastre.

Therefore, the Malaysian multipurpose cadastre should contain essential elements that would enable continuing progress and efficiency. These elements include the data contained in the Certified Plan, Document of Title, taxation and land use & planning

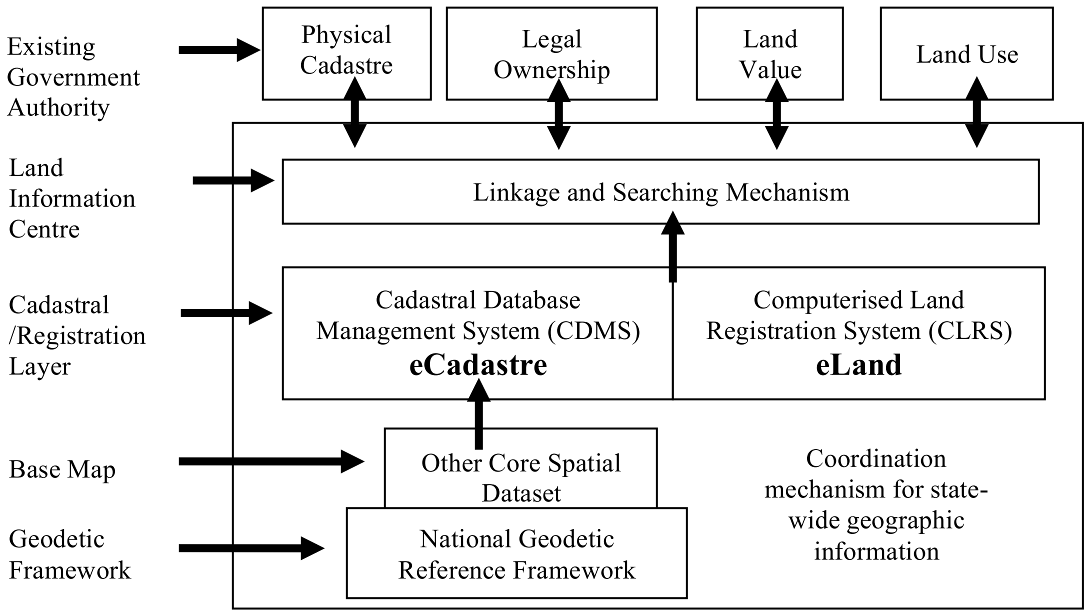

Figure 11: Fundamental framework of multipurpose cadastre

11. CONCLUDING REMARKS

The purpose of this paper is to give a brief understanding and an overview of land administration in general, land tenure and cadastre systems in Malaysia. The empirical study proposed a suitable solution, where possibility of embedding Three-dimensional National Digital Cadastral Database (3D-NDCDB) into the existing National Digital Cadastral Database management model, i.e. introduce height value for each cadastral boundary mark. The important aspect here is the measuring instruments such as Total Station and the GNSS used. They must be in good condition. Good calibration of devices is very important and must be complied with the corrections in data measurements.

According to Tan, Liat Choon (2013), the implementation of each component is carried out by specific institutions at national, regional, and local level. The new system could aim for support land planning, land administration, land taxation, and cadastre. For dissemination purposes, even hyperlinks from the cadastre or its spatial indexes to the data files of land-use planning authorities may be sufficient. However, the multiplicity of organisational and legal relations stresses the importance of structure information and in making information more widely accessible. Efficient data exchange must be focussed on data modelling, standardisation and an appropriate use of the common spatial reference framework.

In addition, there could be wide-ranging benefits if the data information in the Certified Plan from Department of Survey & Mapping Malaysia (DSMM), Registry Title and Land Office Title from State Land & Mines Office (PTG) and District Land Office (PTD), taxation from Valuation & Property Management Department, and category of land use from Town Planning & Development Department are linked together. Furthermore, the integration of the spatial database with the textual database is the prerequisite requirement for the creation of an inclusive land information system, ranging from the town level till the national level. Therefore, with the integration of these data information from various departments and agencies which are responsible for the cadastral survey, title registration, taxation and land use and through the unique parcel identifier that is assigned, the effectiveness of land administration system, land registration system, land information system and cadastre system can be significantly improved.

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