

**DEVELOPING 3D CADASTRE SYSTEM
BASED ON STRATA AND STRATUM
OBJECTS – A Review on Malaysian Situation**

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ABSTRACT

Unified Modelling language (UML) is a design mechanism that involves data modelling and system environment. By using UML class diagram, the Core Cadastral Domain Model (CCDM) and later the proposed 3D cadastre registration model in Malaysia can be clearly elaborated. There are three organisations involve in the cadastre system in Malaysia where Department of Survey and Mapping Malaysia (DSMM) is responsible for carry out land survey and mapping and registration of cadastral objectss while State Land and Mines Office (PTG) and District Land Office (PTD) are responsible for the land title registration. Cadastral Database Management System (CDMS) which stored land attributes, spatial objectss and other things and Computerised Land Registration System (CLRS) which stored land ownerships, land tenures and so on operated by DSMM and PTG as well as PTD. These two systems can be incorporated in the registration form with the present advance and modern technologies such as GIS, internet, web based and e-commerce applications. There

is a need to introduce a new law for the cadastre system if we want to implement 3D cadastre in Malaysia because the current laws of cadastre system in Malaysia still in 2D nature practice while there is high demand in 3D physical real property objects. This is support by information from Abdul-Rahman (2006) that 3D geo-information products and services require huge research and development efforts from national mapping agencies by conducting serious research onto data sources in order to make it more cheaply and potentially. Different government departments and agencies under different authorities and different private sectors are involving for the cadastre system in Malaysia and there is a need of effective institutional arrangement for the registration of 3D strata and stratum objects and improvement of the legal and organisational arrangement.

Keywords: 3D cadastre, registration system, UML, strata and stratum objects, data model, integration

1.0 INTRODUCTION

Malaysia land administration traditionally base on Malaysia land law, where it provided a variety of rights, depending on the traditions at the country. Land use rights are one of the rights that are often based on occupation of land over a long period and can be defined in written law or by traditions. In addition, land as the fundamental or base for all forms human activities where is serves human needs for shelter, labour, the economic needs for business, food, financial and other resources as well as the different kinds of societal needs of the community. Hence, a systematic record of lands in all matter that is registration of the detail of transaction and other things are very importance in the land administration, planning and development of land (Nordin, 2001).

Traditionally, cadastre system in Malaysia consist of land registration system and cadastral survey and mapping registration system which have different structures and authorisations, since land registration is a state government juridical while cadastral survey and mapping is under federal jurisdiction. The Malaysia legalistic cadastre system and land law are still using 2D geometric in legal and law expression for land and property tenure. In addition, the traditionally cadastral survey and mapping registration system and land registration system have not been prepared to register in 3D situation. This means that, due to more and more needs ground space, the 2D paradigm in law and legal should be changed.

There are many countries all over the world as well as Malaysia have not enough of vacant land on surface for rapid development particularly in big cities area. In such big substance and crowded cities, many of the real estate development either above or below the ground surface, strata and stratum objects like flat, apartment, condominium, shopping and business complex and engineering construction like tunnel, underground car park, skywalk and building above road reserve still without proper registration in land registry and cadastre system for 3D purpose. Therefore, to establish more secure ownership and mapping facilities of real estate properties and objects in the cadastre system and land registry, more effort, attention and interest have to be put in. In addition, the sufficiently of handling the registration of the strata and stratum objects in the current cadastral survey and mapping registration system and land registration system in legislative also need to be taken into consideration.

There are three main organisations responsible on managing and maintaining the cadastre system in Malaysia, where Department of Survey and Mapping Malaysia (DSMM) deal with the cadastral survey and mapping where the location, size and dimension of the properties are determine with high accuracy survey as well as responsible for preparing, producing and managing the spatial data while the non

spatial data that is the registration is the responsibility of the State Land and Mines Office (PTG) and District Land Office (PTD) with the ownership registration.

This paper describes a beginning part of a PhD project on development of 3D cadastre system for strata and stratum objects; they are land registration system and cadastral survey and mapping registration system in Malaysia. In Section 2, the paper gives the importance of 3D cadastre. Section 3 gives some explanation on Unified Modelling language (UML). In Section 4, the Core Cadastral Domain Model (CCDM) is exploded. Hence, sub section 4 will give some history of CCDM and explain on class diagram for CCDM. Section 5 starts with the practical solutions towards 3D cadastre registration, namely full 3D cadastre, 2D/3D hybrid cadastre and 2D cadastral with 3D tags. The current practice of cadastral registration in Malaysia and the Malaysia cadastral data model are elaborates in Section 6 and Section 7 respectively. Section 8 continue with the description on the Malaysia cadastral database with the sub section on Computerised Land Registration System (CLRS) and Cadastral Data Management System (CDMS) while Section 9 and Section 10 continue illustrates the development of 3D cadastre registration in Malaysia and the integration of CLRS and CDMS respectively. Finally, Section 11 concludes our work and discusses our current implementation which could be addressed in future research.

2.0 THE IMPORTANCE OF 3D CADASTRE

Since late 1990s, the population of Malaysia has increased from near 21.80 million to 27.73 million (Statistics, 2008) and it is estimated and predicted to reach 31 million by 2020. Hence, efficient 3D land use in real estate is a socio economic and environmental imperative need in Malaysia, where Forrai and Kirschner (2002) illustrate that the availability use of land for future further construction is both

expensive and limited. Therefore, for future and further urban development, the alternatives to the land surface are the space above and below the ground surface and the shallow underwater areas along the seashore where it involve marine cadastral. Both above and below the ground surface developments have been increased over recent years as well as marine development. However, the expensive and hugely cost of construction and the lack of institutionalism especially in the legal and organisational aspects of right to property in strata and stratum, always intimidating cautions potential investors.

In recent years, due to a lot of interest in utilising the above and below the ground surface, there will be a necessary to find a suitable cadastre solution for multi storeys constructions. Therefore, the cadastre system should represent the actual so-called the real world situation and not the surface parcel. Due to arisen demands for the information of 3D to help to reveal more evidences that relate to ownership right on particular property in the real world, the existing cadastre needs to be extended, in order to reflect that situation. It is asserted that:

“... Current cadastre system in Malaysia has to be extended to three-dimensional (3D) system on the existing system is purely 2D and hardly able to provide with good, better and meaningful information ...”

(Abdul-
Rahman, 2006)

In the near future, a cadastre will form complete methodical, comprehensive and updated documentation of public and private rights, ownership, land use and real estate in the various spaces. Concurrently, Benhanu and Doytsher (2001) and Benhanu and Doytsher (2004) illustrated that the 3D boundaries and parcels in space will be determined by 3D cadastre and serve the legal and physical objectives. So, a modern cadastre system should always reflect the

existing situation of all property rights, including mixture of private and public properties. Moreover, this provides a better rationalised management of the built environment, including regulations of legality of use or of economic application (Dimopoulou, Gavanas and Zuntelis, 2006). In order to better represent this evolving reality, it is necessary to develop 3D cadastre with its own legal solution that meets its own needs. On the other hand, the content and role of cadastre haven changed significantly due to the substantial impact on cadastre system, these impacts are mostly come from global economic, social, technological factors and need for sustainable development (Doner and Biyik, 2007). 3D cadastre system will provide information beyond the typical planner data and can be used to make sure registered rights above, on and below the surface of a property. Therefore, land use of above and below the ground surface of a lot, can be thus described, analysed and become optimally developed and exploitable.

3.0 UNIFIED MODELLING LANGUAGE (UML)

The Objects Management Group (OMG) released the Unified Modelling Language (UML) in 1997 (see OMG UML, 2007). One of the purposes of UML was to provide the development community with a stable and common design language that could be used to develop and build computer applications such as become a standard language for objects-oriented software at the conceptual level (Stoter, 2004; Stoter and Van Oosterom, 2006) and Geographical Information System (GIS) application. UML brought forth a unified standard modelling notation, multiplicity and visibility, by using UML, information technology professional like GIS specialist could now read and disseminate system structure and design plans. Also, the language can be used to model the structure schema of a data model at the conceptual level, yet it does provide several types of diagrams that

increase the facility of understanding an application under development because the diagrams offer a good introduction to the language and principles behind its use. Furthermore, by placing standard UML diagrams in our methodology's work products, we make it easier for UML proficient people to join the project and quickly become productive.

There are many types of UML diagrams, the most useful, standard UML diagrams used in core cadastral domain model are: class diagram (shows classes and the relationships between them) and objects diagram (shows the system at a particular point in time) (Stoter, 2004; Stoter and Van Oosterom, 2006). Both diagrams show the elements of the system and the structural relationship. In most cases, the class diagram of UML is used to describe the core cadastral domain model and other cadastre and land administration models.

4.0 CORE CADASTRAL DOMAIN MODEL (CCDM)

The idea for the introduction of a Core Cadastral Domain Model (CCDM) was formally introduced at the *Federation Internationale des Geometres* (FIG) Congress in Washington, April 2002. During the meeting, there was a great attention on standardisation's issue, on top of that, the FIG guide on standardisation was presented and it was decided to continue the work of the FIG Task Force on standardisation in the FIG Standard Network (Lemman and Van-Oosterom, 2003). Furthermore, Stoter and Van-Oosterom (2006) pointed out previous research in recent years shown that a 3D registration of information on land in cadastral systems can offer significant advantages for the legal security of real estate. Yet, it improves insight into rights and

restrictions related to constructions and properties in 3D configurations.

Cadastral system include a database comprising spatially referenced land data, procedures and techniques for systematic collection, updating, processing and distribution of data and a uniform spatial reference system. According to Van-Oosterom, Grise and Lemmen (2003), theoretical and practical developments in Geo-information and Information and Communication Technology (ICT) such as the ubiquitous communication (internet), Database Management System (DBMS), information system modelling standard UML and positioning system will improve the quality, cost effectiveness performance and maintainability of cadastral system.

Van-Oosterom, Grise and Lemmen (2003) also describe a standardised CCDM, covering land registration and cadastre in a broad sense, and will serve at least three goals, there are: (1) avoid reinventing and re-implementing the same functionality repeatedly, but provide a extensible basic for efficient and effective cadastral system development based on a model driven architecture, (2) enable involve parties, both within one country and between different countries, to communicate based on the shared ontology implied by the model, and (3) facilitate cadastre data exchange between in country organisations for example City Hall, Council and Municipality and between countries. In brief, the use of standardised CCDM is to serve and provide an extensible basic for the efficient and effective cadastral system development based on a model driven architecture. This is to avoid the process of repeating reinventing and re-implementing the same functionalities. Besides, the CCDM also provides the common communication platform and facilitates cadastre data exchange within the various parties based on the shared ontology implied by the model.

4.1 History of CCDM

Several CCDM versions have been developed and adjusted each time base on the discussions at the various workshops, and the consultations with several countries all over the world with the well known concept of Person, Parcel and Right. The first version of CCDM was formally introduced at the FIG congress in Washington, USA, April 2002 when a proposal was made by Van-Oosterom and Lemmen (2002a) to develop the CCDM, this first version of model, named “Noordwijk 02”, follow by the second version named “Paris 03”, the third version named “Brno 03”, the fourth version named “Bamberg 04”, the fifth version named “Cairo 05” and the current version of “Moscow 05”.

4.2 Class Diagram for CCDM

The UML class diagram illustrates the relationship between Register Objects (for example real property objects and parcels) and Person (natural person or non-natural person or sometime called subjects) via RRR (right, restriction, responsibility) and this data is the foundation of most land administration. The core of CCDM as depicted in Figure 1 introduced by Van-Oosterom et al. (2006) and extended by Chong (2006) and used by Ahmad-Nasruddin, Hassan and Abdul-Rahman (2008).

According to Van-Oosterom et al. (2006), RRR or originally was an association class between the classes Person and Register Objects and this was a continuous relationship, with the conditions that every Person should at least be associated with one Register Objects and vice versa every Register Objects should be associated with at least one Person. The association class RRR is in the current model replaced by a normal class RRR. The reason for this is that now it is

possible for a unique combination of a specific Person-Register Objects multiple RRR instances can be associated, which was not the case in the construction with the association class RRR that with only one instance could be associated with every unique pair.

A Person can be involved and associated to any number of RRR which indicated in the UML class diagram with the multiplicity of “*” at the RRR ends of the association, while a RRR can involve exactly one Person which indicated in the UML class diagram by omitting the multiplicity, which means “1”. That is the same that, a Register Objects can be associated to any number of RRR, but a RRR can involve only one Register Objects. In the current model there is no direct relationship between Person and Register Objects, but only via RRR.

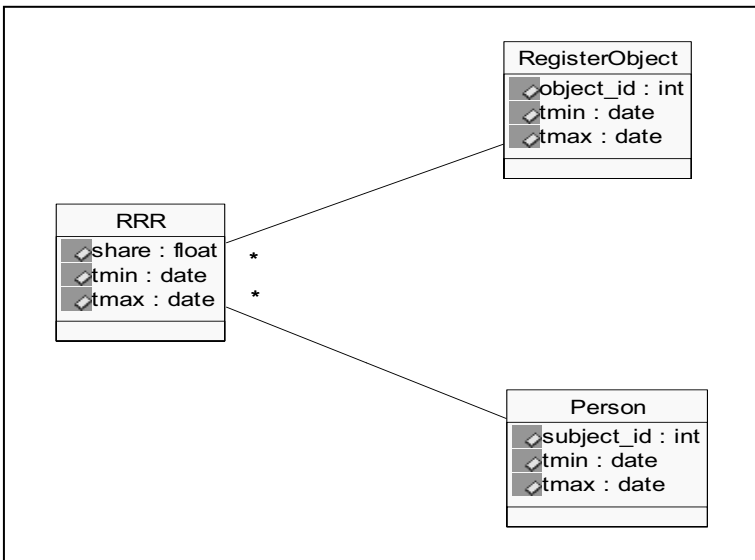


Figure 1: UML class diagram of Core Cadastral Domain Model (CCDM): Person, RRR (right, restriction, responsibility) and Register Objects (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

5.0 REVIEWS ON PRACTICAL SOLUTION

The vast development today makes an essential increasing demand for 3D situations to support the volume parcels in real property objects. Therefore, one of the three fundamental concepts proposed by Stoter (2004) can be used to cater and solve those problems which occur with some minor modify, in order to suite with the cadastral survey and mapping registration system and land registration system for each respective country. Three fundamental concepts with several options are as follow:

- a) Full 3D cadastre
 - Option 1: combination of infinite parcel columns and volume parcels that is combined 2D/3D alternative.
 - Option 2: only parcels are supported that are bounded in 3D volume parcels.

- b) 2D/3D hybrid cadastre
 - Option 1: registration of 2D parcels in all cases of real property registration and additional registration of 3D legal space in the case of 3D property units.
 - Option 2: registration of 2D parcels in all cases of real property registration and additional registration of physical objects.

- c) 2D cadastral with 3D tags linked to parcels in current cadastral registration.

5.1 Full 3D Cadastre

The concept of full 3D cadastre is to introduce the property rights in 3D space, which is being subdivided into volume parcels partitioning the 3D space. So as to support this hypothetically concept and final solution, the legal basic, real property transaction protocols and cadastral registration should corroborate the establishment and conveyance of 3D rights. In this approach, the 2D cadastral map does not has any relation on 3D rights that entitle persons to volumes, that means, rights and restrictions are no longer established on parcels, but explicitly related to well defined volume parcels. One good example for real property objects that will be defined in 3D are strata and stratum units. However, to realise this full 3D cadastre solution, it requires a significant changes in the cadastral survey and mapping registration, land registration technical frameworks as well as the legislative framework. For a full 3D cadastre, the same UML CCDM is still applicable (see Figure 2); it differs only in how the object is being defined. While, the cadastral objects in the Register Objects class are defined in 3D as 3D parcel, with RRR (right, restriction, responsibility) and Person related to the 3D parcels. There shall be no relationship between surface parcels and the 3D physical objects, as both are not represented.

In conclusion, the first option in full 3D cadastre mentioned above, is possible to establish parcels that are defined with boundaries on the surface because the volume parcels are only established in 3D situations. The first option convert the conventional parcels representation into 3D, meaning that, a parcel defined by the boundary on the surface is converted into an indefinite parcel columns and volume parcels that intersects with the surface at the location of the parcel boundary. While the second option, the only real property objects that are recognised by the cadastre are volume parcels and it form a complete partition of space, so, here, it is no longer possible to

entitle persons to infinite parcel columns defined by boundaries on the surface, but only to well-defined, totally bounded and surveyed volume (Stoter, 2004). The implementation of this with the 3D volume parcel full 3D cadastre solutions challenge on the traditional doctrine of land ownership as cone down to the centre of the earth. In order to define the extent of ownership in the vertical plane, it required extensive and complicated overall 3D land title settlement prior to cadastral survey. On the other hand, change in the relevant land law on the legal aspect is required, but it is a long process.

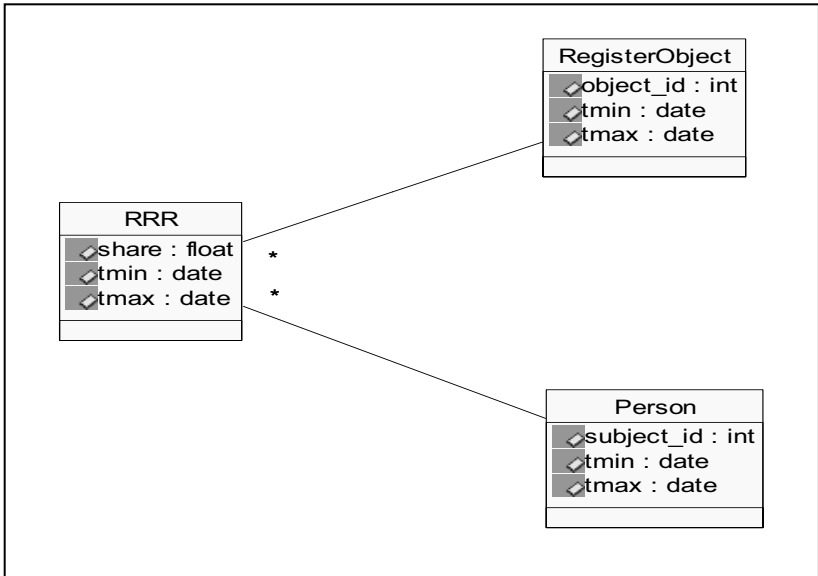


Figure 2: UML class diagram of full 3D cadastre (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

5.2 2D/3D Hybrid Cadastre

The 2D/3D hybrid cadastre solution means that the 2D cadastre and the integration of the factual situation in 3D space of registering the 3D objects within the 2D cadastral registration. This solution of the separate legal registration of 2D parcels and the 3D situation are combined and integrated. The hybrid solution of cadastral registration of the 3D situation gives insight, but is not juridical binding, that means, the exact legal situation still depend on reliable documents like Certified Plan (CP) recorded in the land registration with the description of the volume that had agreed and will use in the 3D registration. The 3D representation can be either the volume to which a person is entitled, that is the registration of 3D right objects defined by the surface parcel bounded by the upper and lower limits or registration of 3D physical objects itself. In this solution, the same UML CCDM is still applicable for this option with an additional class of 3D Representation. This 3D Representation can be either the 3D right volumes (registration of 3D legal space) or a physical objects itself (registration of 3D physical objects) (see Figure 3).

To conclude, the first option implies the 3D registration of rights that are already registered and that are concerning 3D situation using 3D right volumes, which the parcel is the starting point of registration. While the second option is the registration of 3D physical objects themselves, which a physical object is the starting point of registration by which constructions are integrated in the cadastral data as in buildings in the current cadastral registration. The UML class diagram models of these two approaches are illustrated in Figure 4 and Figure 5. The juridical and cadastral concept of ownership and property will remain the same. Which mean, rights are always established and registered on 2D parcels, while an owner of a parcel can be registered in using the whole infinite parcel column by limited right and legal notifications (Stoter, 2004).

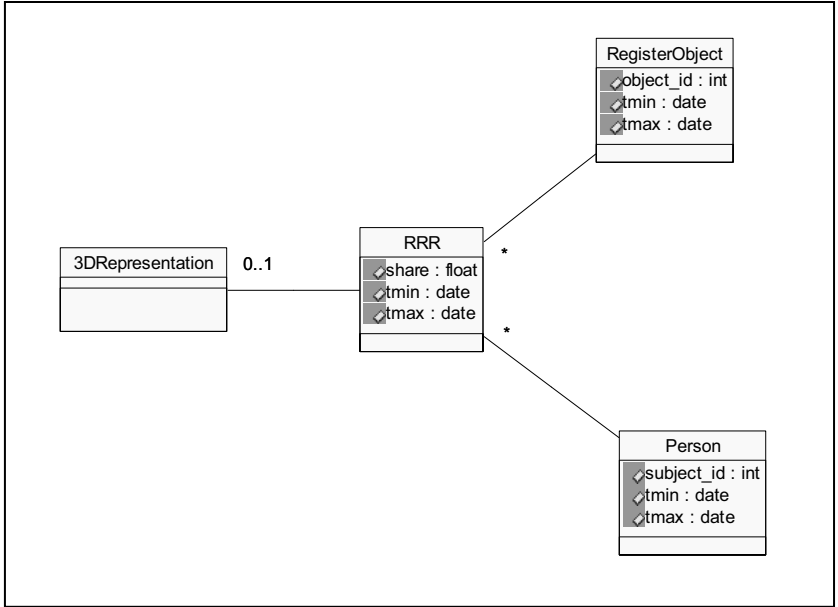


Figure 3: UML class diagram of 2D/3D hybrid cadastre (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

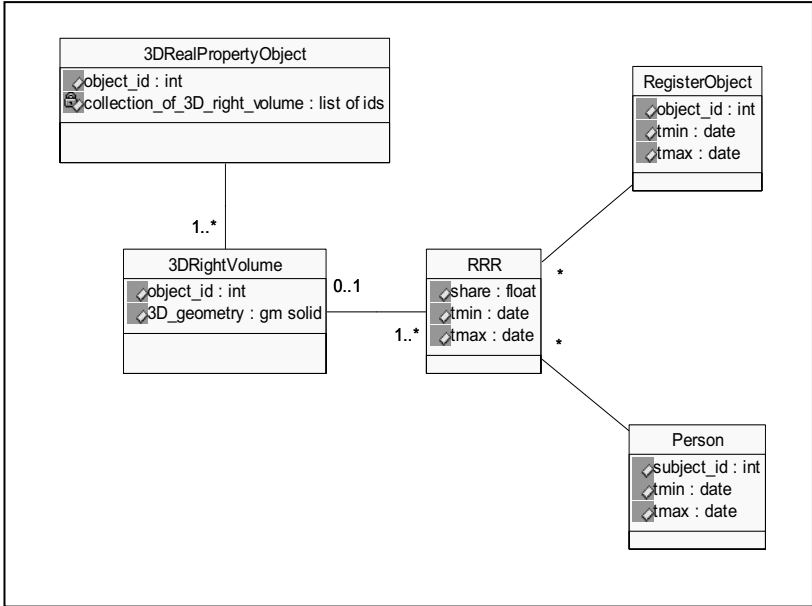


Figure 4: UML class diagram of 2D/3D hybrid cadastre (3D Right Volume) (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

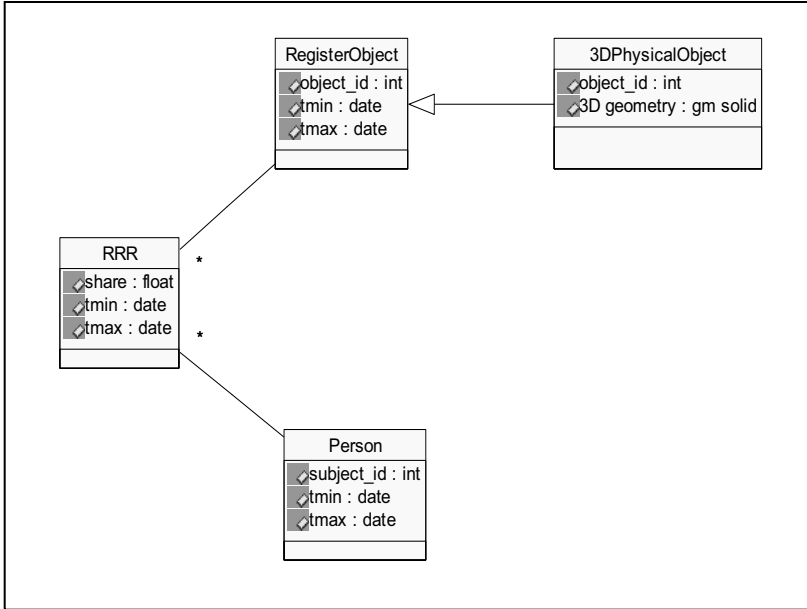


Figure 5: UML class diagram of 2D/3D hybrid cadastre (3D Physical Objects) (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

5.3 2D Cadastre with 3D Tags

In this 2D cadastre with 3D tags solution, the existing 2D cadastre is being maintained in its original state, but with external references linking to 3D digital drawing or 3D analogue to represent the 3D situations. The external reference linking to the 3D situations can be a single tag (3D_tag: Boolean, whereby user needs to refer to the registration documents for detailed information) or a reference link

(3D_link: url_string) to the digital drawing file maintained in the cadastral registration (see Figure 6). In this solution, the complex 3D situations are registered using ad hoc solutions within current registration possibilities, while every right that is registered can be attributed with a reference to a 3D representation. The difference between 2D/3D hybrid cadastre and 2D cadastre with 3D tags is that the 3D representations in the second approach are maintained separately and not integrated with the cadastral data.

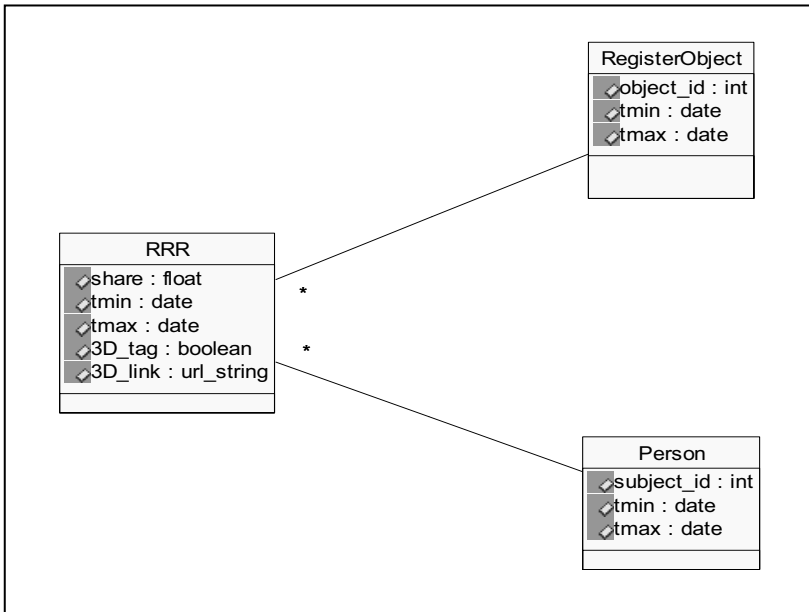


Figure 6: UML class diagram of 2D cadastre with 3D tags to 3D situations (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

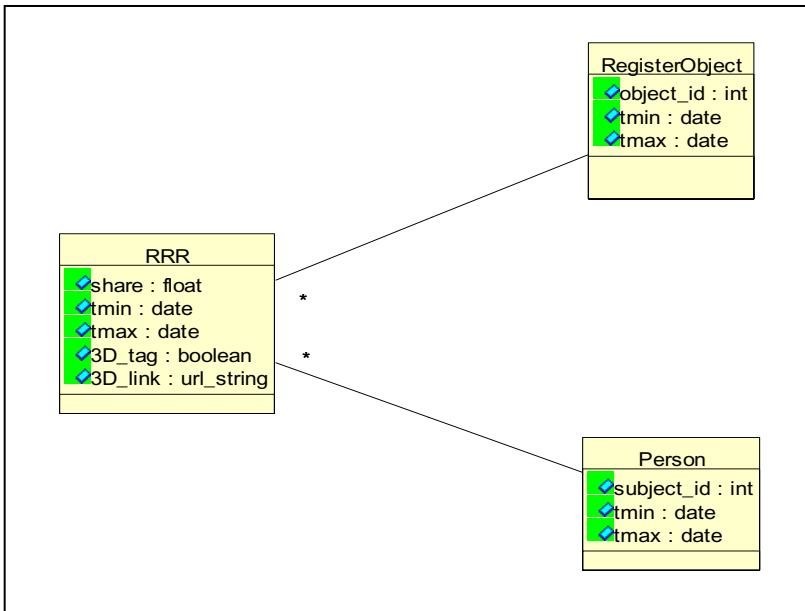


Figure 6: UML class diagram of 2D cadastre with 3D tags to 3D situations (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

6.0 CURRENT PRACTICE OF CADASTRAL REGISTRATION IN MALAYSIA

The traditional cadastre registration system that is practiced in Malaysia are parcel bounded system with 2D nature and provide essential lands and properties information of the lots and land parcels (Hassan, 2008). Furthermore, Valstard (2006) points to the fact that

traditionally land has been described and registered into 2D and all cadastre systems of the world are in fact 2D nature. The existing traditional Malaysia cadastral survey and mapping registration system and land registration system deals with properties not only located on the surface level, but above the surface level and also below the surface level. Therefore, the rights, restrictions and responsibilities (RRR) of the proprietor of the surface parcel shall also apply to the proprietor of the above that is air space, and underground land as well and we will further discuss and look into the code and act which related to lot, land parcel and land registry such as National Land Code (NLC) 1965, Strata Title Act (STA) 1985, Federal Constitution (FCS) 1957 and so on.

The current Malaysia cadastral registration system does not consists and includes 3D objects registration and 3D rights as well, but this current system is more similar to land administration system. As stated in ECE/HBP/96 (1996), land administration consists of cadastral survey and mapping registration system and land registration system where both of them contain a set of records about land. This type of 2D cadastre system being practice in Malaysia for a period of one hundred years and it provides essential information about land and property like ownerships of the lots and land parcels for the country. In Malaysia, the cadastre system is managed by three main authorities namely DSMM, PTG and PTD. In general, cadastral survey and mapping is under the jurisdiction of DSMM where it responsible for carrying out land survey and mapping, then follow by registration of cadastral objects there are lots and land parcel boundaries while PTG and PTD are responsible for the land title registration; they are Registry Titles and Land Office Titles.

There are two systems namely Cadastral Database Management System (CDMS) and Computerised Land Registration System (CLRS) which operated by DSMM and PTG as well as PTD. The CDMS database stored land attributes, spatial objects and other things while the CLRS database stored land ownerships, land tenures and so on, but these two systems works separately in each organisation with

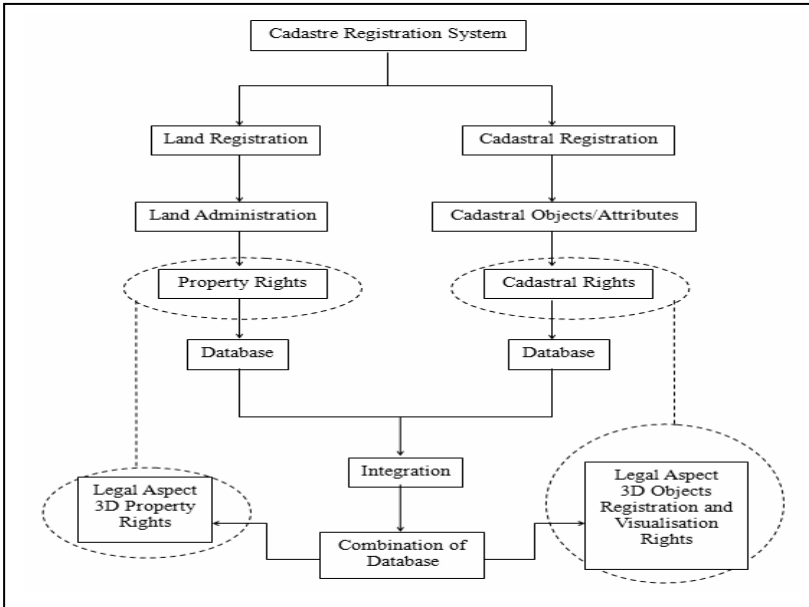


Figure 7: Current cadastral system with proposed concept of rights

7.0 MALAYSIA CADASTRAL DATA MODEL

The CCDM which introduced in the current version of model (Van-Oosterom et al., 2006) mentioned that this data model is the foundation of most land administration. Which means that, this foundation of core cadastral data model is designed for various land registration system and cadastral system all over the world and as a base for all cadastral registration, therefore, in other words, the relationship between the three core classes in the UML diagram as in Figure 8, there are Person (subject), RRR (right, restriction,

responsibility) and Register Objects (real property objects), can used to illustrate Malaysia Cadastral Data Model.

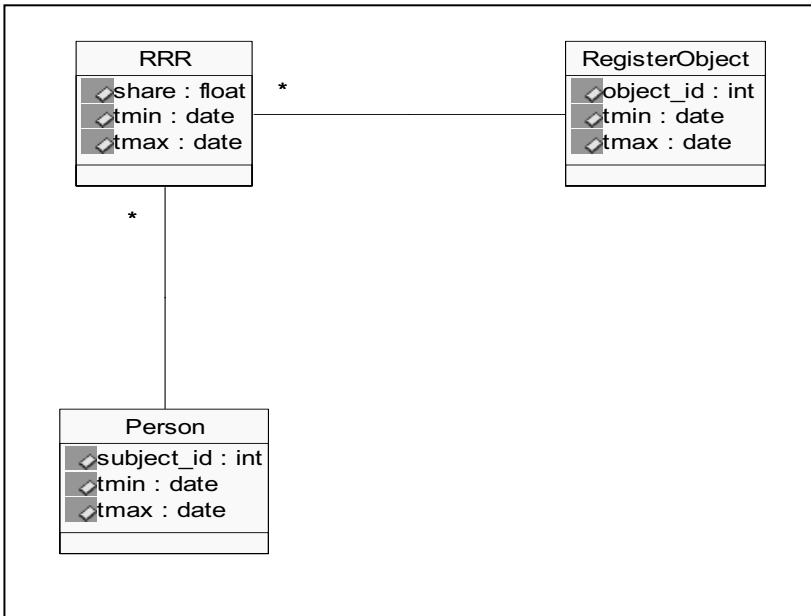


Figure 8: UML class diagram of Core Cadastral Domain Model (CCDM): Person, RRR (right, restriction, responsibility) and Register Objects (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; and Chong, 2006)

8.0 MALAYSIA CADASTRAL DATABASE

The arrival of computer and the rapid development of ICT has resulted widespread technological reforms in the field of cadastral system and in line with the government objective of providing efficient and quality land administration services to the public. Realising the importance and potential of this new technology, DSMM and PTG had initiated their computerisation programme in the early 1980’s and

1990's respectively. The most significant change that ICT has brought about is that the shift from conventional analogue data to digital data and consequently the introduction of the concept of digital database which forms the base component of a Land Information System (LIS) which in turn has been identified as having an indispensable role in the process of decision making in resource management and planning. For example, PTG has computerised two of its main operations in land administration named Computerised Land Registration System (CLRS) and land Revenue Collection System (LRCS) to cater the land registration and revenue collection activities. On the other hand, DSMM has implemented a data collection and processing facility named Cadastral Data Management System (CDMS) for cadastral activity, the Computer Assisted Topographic Mapping (CATMAPS) for mapping activity and also the Automated District Survey Office System (ADSS) for district survey office activity, and then both CLRS and CDMS enabled the process of land registration and measurement of ownership to be accelerated (Chong, 2006).

8.1 Computerised Land Registration System (CLRS)

The Torrens system, based essentially on the Fijian Act, was introduced into Peninsular Malaysia between the years 1879 to 1890 and later become the back bone for the NLC 1965 in Peninsular Malaysia, the Sabah Land Ordinance 1930 in Sabah and the Sarawak Land Code 1958 in Sarawak. Under this Torrens system, the register reflects all the facts material and evident to the registered owner's title in the land. These material facts mentioned such as the name of the proprietor for the time being, the alienated land, area, location, survey plan boundary limits as well. According to Das (1963), the Torrens system has thus endowed the register with two attributes. First, an attribute of a mirror of sorts that can reveal all the necessary

particulars relating to the land that would interest a potential purchaser or charge, it can also call “the mirror principle”. A second attribute of the Torrens system is that the register becomes a “curtain”, this means, in any transaction between the registered owner and any potential purchaser, the latter will be concerned only with the register and nothing else and the purchaser can safely rely on the information revealed in the register, and no need to look behind it to search for the history like what in the Deeds system. In addition, the cumulative effect of these principles is that the Torrens system has conferred on indefeasibility of title to the registered owner.

In fulfilling the requirements of Act A832, the NLC 1965 has been amended in 1992 to add on section 5A and 5B. That is to introduce the CLRS into land registration throughout the country. Section 5A in NLC 1965 explain the term of Land Registry and gives a right for a registrar and explain the responsibilities related to the produce, dealing, endorsement or correction on any document of title and shall be read with the modifications, amendments, additions, deletions, substitutions or adaption as provided in the Fourteenth Schedule while the approval of the National Land Council, by order published in the Gazette of the Federation, make any amendment to any of the Forms in the Fourteenth Schedule that necessary, desirable or expedient. With the implementation of the CLRS, a system to modernise and to facilitate the registration of land title and dealings, data are extracted from both the documents of title and other land related documents. Meanwhile, the information in the CLRS database are based on the records kept in the land registers and relevant files with include information on ownership (Person), land identification (Register Objects), restriction (RRR) and record of dealings. As mentioned by Chong (2006), the register furnishes all information pertaining to the ownership (person), the land (objects, through description of area and location and boundary limits from the CP and rights (details of encumbrance, expressed conditions, caveats and prohibitory orders and other things)). However, not all restrictions are stated in the register, some are implied by law for example NLC 1965, planning control and so on.

8.2 Cadastral Data Management System (CDMS)

In 1986, a Computer Assisted Land Survey (CAL S) system which generated the Digital Cadastral Database (DCDB) at a scale of 1:4000 was initiated for Johor as a pilot project. After that, the success of this CAL S system pilot project led to the implementation of another CAL S system project in Pahang in 1993. The confidence gained by the successful implementation of earlier CAL S system projects in Johor and Pahang, and encouraged by the demonstrated increases in efficiency and productivity in the production line, has led to the introduction in the Mini-CAL S system throughout the remaining state survey departments of Peninsular Malaysia in 1995 . After that, a Document Image Management System (DIMS) will be implemented in all state survey departments and will integrate the existing CAL S system and it's DCDB. The integrated system then know as the Cadastral Data Management System (CDMS) and will provides a network for the survey department to access the DCDB and the digital image library from any personal computer within the network, with a single window and single point of access. DCDB holds digital cadastral base maps that are used for building up GIS and land related applications, while the image library holds scanned and indexed CPs stored in the disk arrays at every state survey departments. CDMS is also capable of receiving orders from clients through remote access, e-mail, dial-up and other things as well as providing an automatic invoicing, billing and accounting system and it also cater for remote access to and from the District Survey offices. A system which forms part of the CDMS that is Quality Assurance System (SPEK) is a module to preserve the integrity, and accuracy of the DCDB.

9.0 REVIEW OF 3D CADASTRE REGISTRATION DEVELOPMENT IN MALAYSIA

The development of 3D cadastre registration are more on technical part where researchers study on the process of adding 3D cadastre objects in the current cadastre data model and information accessible among DSMM, PTG and PTD, unfortunately the two state database which are DCDB and CLRS database works separately in different authorities and still in 2D situation. As mentioned in this research previously, Malaysia land administration are based on the Torrens system where Cadastral Map and legal document with spatial and textual information as a legal evident under the rules and regulations are needed in order to have fully institutional coordination. Therefore, a good institutional is very important, so as to achieve an excellent and wonderful cadastre registration system. However, due to many historical constrains, it seems quite difficult to realise this unless with fully cooperation from various legislative agencies, technical agencies, organisations and other land related government and private sector as well. Recently, the 3D cadastre proposed registration model focused on the combination of these two different databases mentioned above and these two cadastre registration databases namely the legal rights land attributes and the spatial objects geo-data. These three authorities, DSMM, PTG and PTD that are mentioned above are the main government agencies that responsible for the cadastre registration system where they integrate and coordinate each other, in order to have an integrated and fully cadastre system in Malaysia using the 2D/3D hybrid cadastre approach (Stoter, 2004). Figure 8 shows the 3D cadastre objects in land registration model where the CCDM as mentioned in Section 4 is still applicable for this alternative with a additional class of Legal Rights.

The 3D cadastre objects such as strata building, construction above and below the ground surface, they are underground tunnel, metro station, skywalk and other things is a real property objects that being

built on the 2D land parcel, which are the responsible by PTG, PTD and DSMM on the ownership registration and objects registration respectively. Apart from this 2D land parcel, there is also a 3D land parcel, which is similar to 3D physical objects based on the hybrid solution by Stoter (2004), together form from the Register Objects, where the 2D land parcel is represented as a 2D geometry while 3D land parcel is form with 2D geometry and 3D information. Figure 9 shows the 2D land parcel and 3D land parcel, both registered as an object in current registration system.

The 2D Land Parcel is inherited from the current registration system that is the cadastral lot that consists of boundary lines and boundary marks. On the other hand, 3D Land Parcel is projected with the 3D bounded space that consists of face, node and vertex with list of coordinates that form flat faces and forming of 3D objects which so-called 3D cadastre objects later. Figure 10 shows the 2D land parcel data model inherited from Register Objects in the cadastral registration. Meanwhile, Figure 11 illustrates the 3D land parcel data model inherited from also from Register Objects in the cadastral registration.

To sum up, 3D cadastre registration is a combination of land registration with 2D and 3D land parcel of cadastral registration. There are combination of legal rights of land attributes, 2D cadastral objects and 3D information. The combination of this concept data model can be shown in Figure 12.

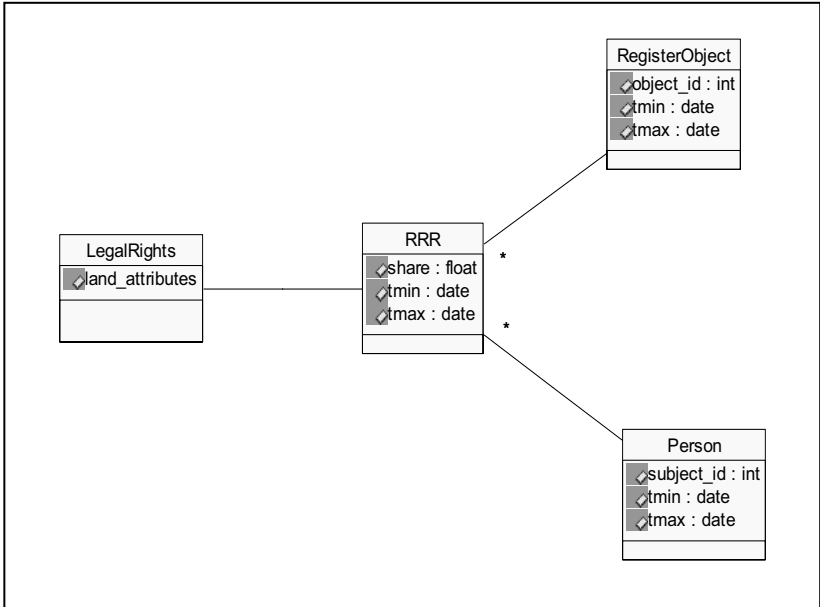


Figure 8: UML class diagram of 3D cadastre objects in land registration model (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; Chong, 2006; and Ahmad-Nasruddin, Hassan and Abdul-Rahman, 2008)

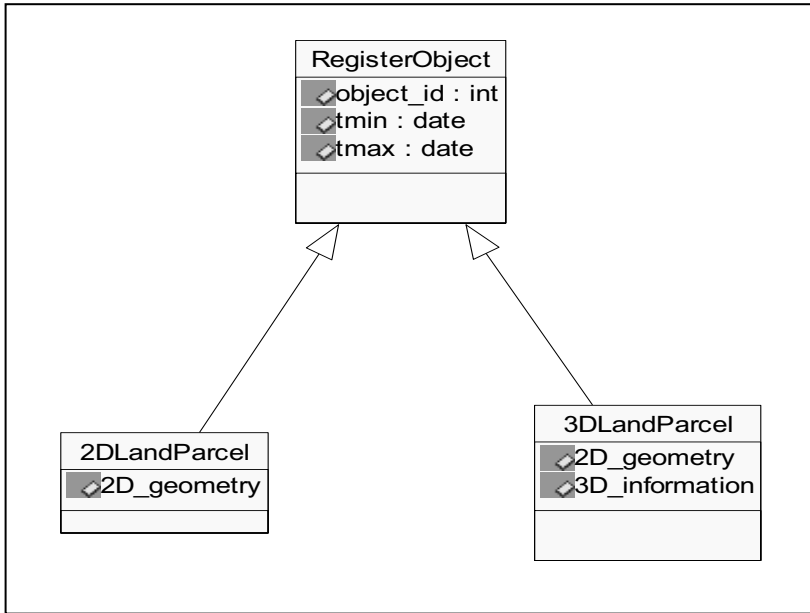


Figure 9: UML class diagram of 2D land parcel and 3D land parcel data model (Adapted from Stoter, 2004; Van-Oosterom et al., 2006; Chong, 2006; and Ahmad-Nasruddin, Hassan and Abdul-Rahman, 2008)

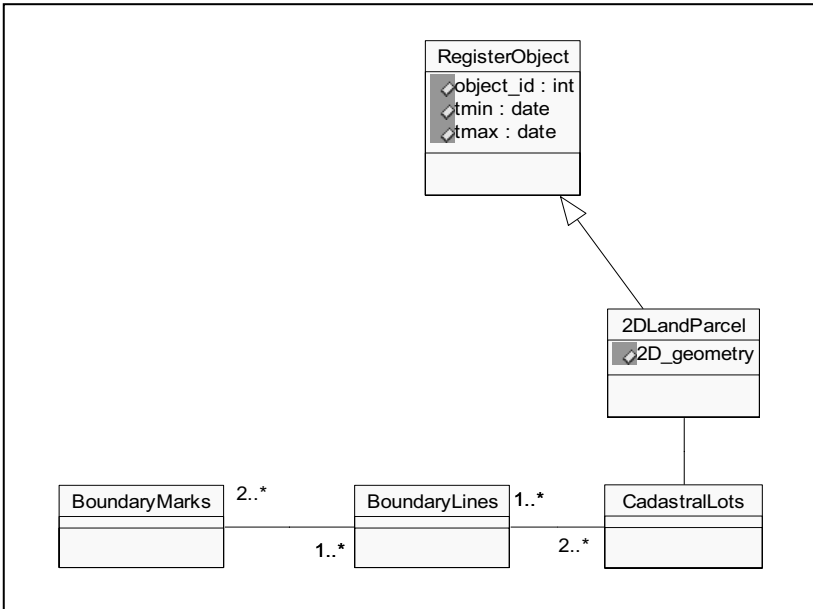


Figure 10: UML class diagram of 2D land parcel data model in cadastral registration (Adapted from Ahmad-Nasruddin, Hassan and Abdul-Rahman, 2008)

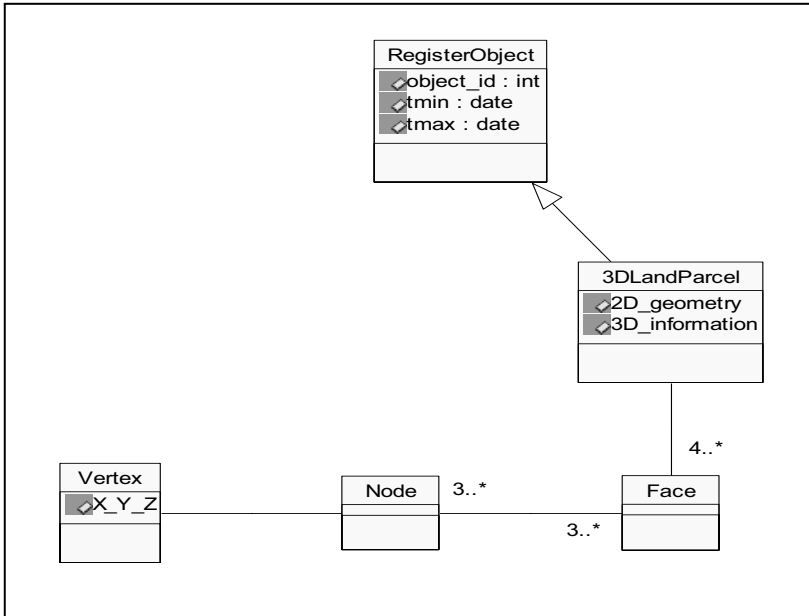


Figure 11: UML class diagram of 3D land parcel data model in cadastral registration (Adapted from Ahmad-Nasruddin, Hassan and Abdul-Rahman, 2008)

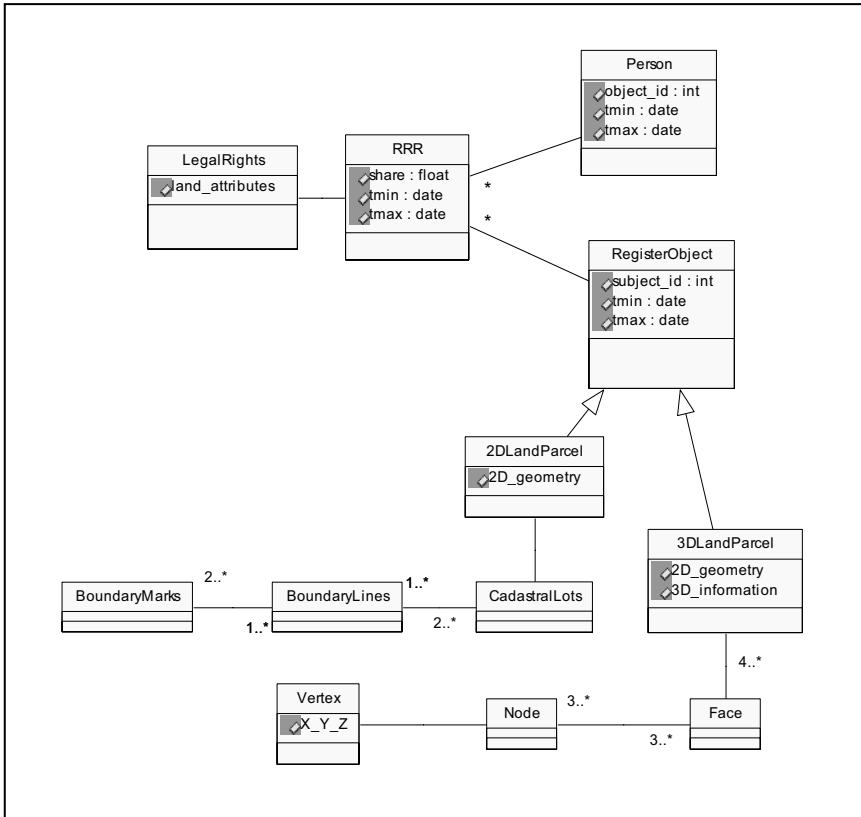


Figure 12: UML class diagram of 3D cadastre registration concept data model (Adapted from Ahmad-Nasruddin, Hassan and Abdul-Rahman, 2008)

10.0 INTEGRATION OF CLRS AND CDMS

There could be extensive benefits if these two systems, which are CLRS of PTG and CDMS of DSMM, are linked together. For that reason, a pilot project being started in Kuala Lumpur in 1st April 1995 to electronically connect and integrate the CLRS with the CDMS for

the whole Kuala Lumpur then to develop the operational systems that can subsequently be implemented throughout the country in Peninsular Malaysia. Therefore, with the integration of attribute data from CLRS and spatial data from CDMS and through identified application, efficiency of land administration can be greatly improved. Nordin (2001) stated that the envisaged applications include on-line registration for survey and preparation of title, extending DCDB enquiry module to the land administrators and on the hand, linking the Qualified Title (QT) information to the DCDB. Although conceptually tenable, the eventual implementation would need substantial negotiation and compromising in between PTG and DSMM.

With the vast changing in the ICT, such as GIS, internet and web based application and together with the initiative of Malaysian Geospatial Data Infrastructure (MyGDI) National Spatial Data Infrastructure (NSDI), E-Tanah of Ministry of Natural Resources and Environment (NRE) and E-Cadastre of DSMM, CLRS and CDMS database could be integrated electronically. In order to achieve the goal of comprehensive LIS from district level up to state and eventually at the national level, the integration of spatial CDMS database with the textual CLRS database play a preliminary requirement of all these. Moreover, Mariappan (2005) introduced a mechanism to integrate these two standalone databases. Coordination among DSMM, PTG and PTD can be provided by the installation of centralised server or distributed server at each of their office which act as the transporters and bridges in exchanging data between CLRS and CDMS. Figure 13 illustrates the conceptual integration of cadastral survey and title registration databases. Although there are a lot of benefits from an integrated textual title registration database and the graphic as well as spatial cadastral database, but there are still many hurdles to solve at this stage. Mariappan (2005) also underlines the following issues associated with the integration (expected solution given in parenthesis).

- a) Organisational-there is no mechanism for exchanging data among organisation (through E-Tanah and E-Cadastre);
- b) Technological-compatibility of existing hardware and software (through advance technology);
- c) Data-data quality and integrity (through standardisation for example ISO TC/211, SIRIM MS 1759 and Unique Parcel Identifier (UPI));
- d) Legal-data custodian and rights (through amending current related guideline and law); and
- e) Different working procedures and practices (through minimisation and integration).

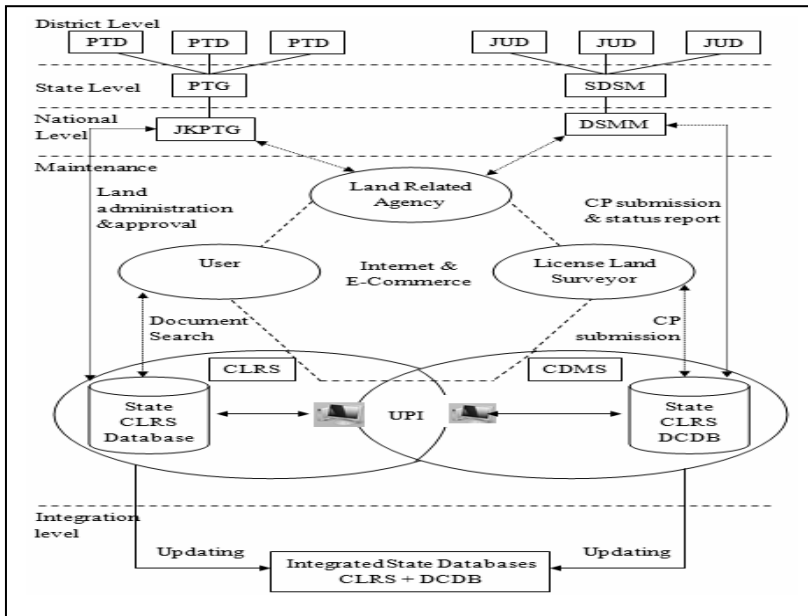


Figure 13: Conceptual model to integrate CLRS and DCDB (Partly adapted from Mariappan, 2005)

11.0 SUMMARY

Research on 3D cadastre have been carried out in several countries like in the Netherlands, Norway, Sweden, Denmark, Finland, Canada, Australia, Israel, Turkey and Greece, even some of these countries such as the Netherlands, Sweden and Norway had implemented law for 3D cadastre, but most of these works are still not operational and still needs a lot of research efforts (Hassan, Abdul-Rahman and Stoter, 2006) in legal and organisational aspects before it could be fully implemented and realised in Malaysian law of cadastre. This paper is part of the research on developing Malaysian 3D cadastre system. As mentioned earlier, besides the technical aspect, legal and organisational aspects also play an essential role and cannot be ignored or separated from the 3D cadastre main body, therefore, all of these aspects should work together and concurrently. In short, this paper can be an initial start for research on the legal and organisational aspects for developing Malaysian 3D cadastre system for strata and stratum objects.

There are a number of aspects of good governance in modern societies that require a strategic response of land administration and cadastre legal and organisational and cadastre as a field of activity, important in early and today societies due to its role in economic development and environment management. Zevenbergen (2004) give an overview of the land registration and cadastre where the right system will be a great help and facilitator in achieving legal security of right holders and purchasers. Specialists from many countries have been carrying out their works about real property objects in determining the legal and organisational status and had made the subject of using under and above surface, projects and works a current issues and today it is a need to define and register these objects both technically and legally. The comprehensive solution of 3D registration in future can be avoided by the registration of all real objects above and below the

surface as 3D properties in land registry. So, the legal and organisational aspects of registering strata and stratum objects in Malaysia cadastre system should be a new field of research in the both legislative and organisational frameworks in 3D cadastre.

In conclusion, the core of this research attempt to investigate problems occurs in 2D situation and format of Sale and Purchase Agreement, Property Valuation Report and Cadastral Map for strata and stratum objects property. By using the 2D/3D hybrid cadastre approach to register the 3D strata and stratum objects, a graphic and visualisation interface that consist of several strata and stratum objects technical structure volume model will be developed. The proposed conceptual models are evaluated and translated into a prototype implementations using the techniques and theories explored and developed as part of the research and by performing verification tests. Finally, this research will end with a solid validate proposal that to amend the current legal and organisational practice.

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