3D Strata Objects Registration for Malaysia within the LADM Framework

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SUMMARY

This paper discusses 3D objects registration and modelling for cadastral objects within the Land Administration Domain Model (LADM) framework. A conceptual model as well as the associated technical model for the 2D and 3D objects have been proposed and developed for Malaysia. For both private and public land, the main subdivision of land in Malaysia is based on lots. In many continental European countries, 'lot' would be called 'parcel', but 'parcel' has other meaning in Malaysian context. The lots can have 2D or 3D representations. The Strata Title Act and Strata Management Act are very important for a large part of the Land Administration in Malaysia, and this is especially true for many 3D related situations. The Malaysian LADM country profile includes the support for these strata objects: building and building parts (all in 3D within a single lot), land parcel (with house no more than 4 storeys within a single lot), which can be refined with parcel unit, accessory unit, and (limited) common property unit including support for provisional and multilayer/underground aspects. In addition, the Malaysian country profile also supports the legal spaces for utilities. By developing a Malaysian country profile based on the international standard ISO 19152, the possible confusion related to terminology (e.g lots, parcels, strata, 2D, 3D) has been resolved. This is not only important for Malaysia, but also useful for many other countries, that have the strata title system.

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1. INTRODUCTION

The concept of strata title grew out of the development of the Torrens system, which was devised by Robert Torrens in South Australia in 1857. Under Torrens system, for each parcel of land or lot, there is one document of title, namely Register Document of Title in Malaysia. This document contains the essential legal information about the title (Strata Title Act, 1985). The Strata title was first introduced in the National Land Code 1965, which dealt with subsidiary titles. This was a response to the rapid growth of urbanization, which was taking place at the time and the need to resettle urban squatters, as well as a demand from the public for the right to own their own flats and apartments. The idea of strata title is based on the horizontal subdivision of building, or of airspace, instead of the normal vertical subdivision of land. The discussion of the recent strata development has been revised in the Strata Titles (Amendment) Act 2013 (STAA 2013). The amendments under STAA 2013 include the introduction of the Electronic Land Administration System of Strata Titles, the designation of limited common property, and the creation of one or more subsidiary management corporations to represent the different interests of parcel proprietors.

LADM provides a conceptual model to build concrete application including 3D strata objects registration. This paper only focus on the 3D strata components where detailed discussions of the proposed model will be highlighted with prototype development emphasised by using small datasets. This paper is organized as follows. Section 2 discusses the 3D strata objects registration in Malaysia. The conceptual model of the Malaysian LADM country profile is described in Section 3. The technical model including the development of the prototype based on Oracle spatial and Bentley Microstation is presented in Section 4. Finally, the conclusions are given in Section 5.

2. 3D STRATA OBJECTS REGISTRATION

In Malaysia, all multilevel buildings with multi-owner have a Management Corporation (MC). The Management Corporation is a body corporate of which all proprietors are automatically members, and it has the responsibility of administering the strata scheme, including looking after maintenance of the common property, enforcing bylaw and collecting levies from the proprietors to finance necessary expenditure. Proprietors' voting rights and liability to contribution for expenditure are assessed according to their share units or unit entitlements.

The owners (of the parcels) need to get, keep and preserve strata title of their units for the following reasons (Strata Title Act, 1985):

i. As ultimate proof of ownership.

ii. As a dealing instrument for instances of charging to banks for loans.
iii. To facilitate disposal should they wish to sell so that they will not be imposed 'consent fees' by the developer.
iv. To be able to initiate and get involved when the Management Corporation (MC) is formed by owners of the units in the sub-divided building to maintain and manage the property.
v. As a final proof of the built-up area of the unit and ultimately, the appointment of the share in the total aggregate units.
vi. As long as strata titles have not been transferred, the land and common property are still owned by the developer.

If a building development project is insolvent before strata title is obtained, the unit owners will have to go through a lot of trouble or might eventually have to pay for the application of the strata titles themselves (Strata Title Act, 1985).

Figure 1 illustrates the various types of strata objects in Malaysia. A *parcel* in relation to a subdivided building, means one of the individual units comprised therein (apartment or condominium), which is held under separate strata title. An *accessory unit* means a unit shown in a strata plan, which is used or intended to be used in conjunction with a parcel. A *common property* means so much of the lot as is not comprised in any unit (including any accessory unit). A *limited common* property means common property designated for the exclusive use of the owners of one or more strata lots. A *land parcel* means a unit delineated within the lot (in which is comprised a building of not more than four storeys) which is held under a strata title and which may have shared basement, accessory unit and common property.

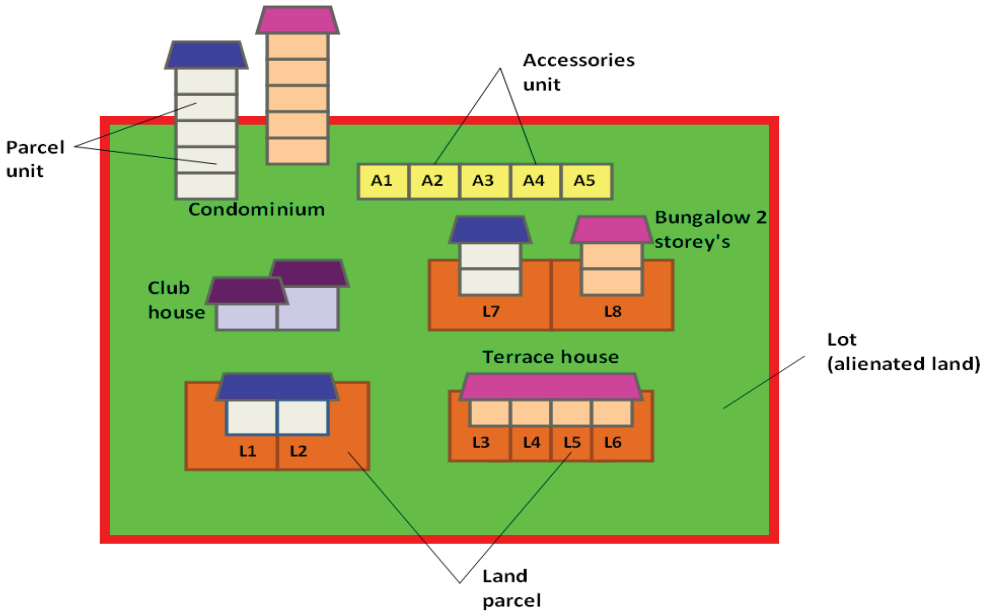

Figure 1. Various cadastral objects related to strata titles within a lot

3. CONCEPTUAL MODEL

All classes in the Malaysian country profile are based on the inheritance of the LADM classes (Zulkifli et al, 2014a) - the 'MY_' is the prefix for the Malaysian country profile, covering both the spatial and administrative (legal) data modelling. To illustrate the inheritance from the LADM classes, the MY_classes have either in upper right corner the corresponding LA_class name in italics or have the explicit inheritance arrow shown in the diagram (see Figure 2).

3.1 Spatial part

The country profile that has been developed for the 3D spatial unit represents building, utility and lot. The building is represented by MY_Building class and utility represented by MY_Utility class. Both MY_Building and MY_Utility are subclasses of MY_Shared3DInfo (a specialization of LADM's LA_SpatialUnit), containing common attributes such as a GM_Solid geometry attribute, a variable length volume attribute with at least one LA_VolumeValue and a Boolean attribute indication whether the object is provisional or not. Meanwhile, a 3D lot is represented by MY_Lot3D, which is a subclass of MY_GenericLot (which is in turn also a subclass of LA_SpatialUnit). MY_GenericLot has another subclass called MY_Lot2D. Both MY_Shared3DInfo and MY_GenericLot are abstract classes and do not have any instances. Figure 2 illustrates the associated spatial component (with strata classes in darker colour).

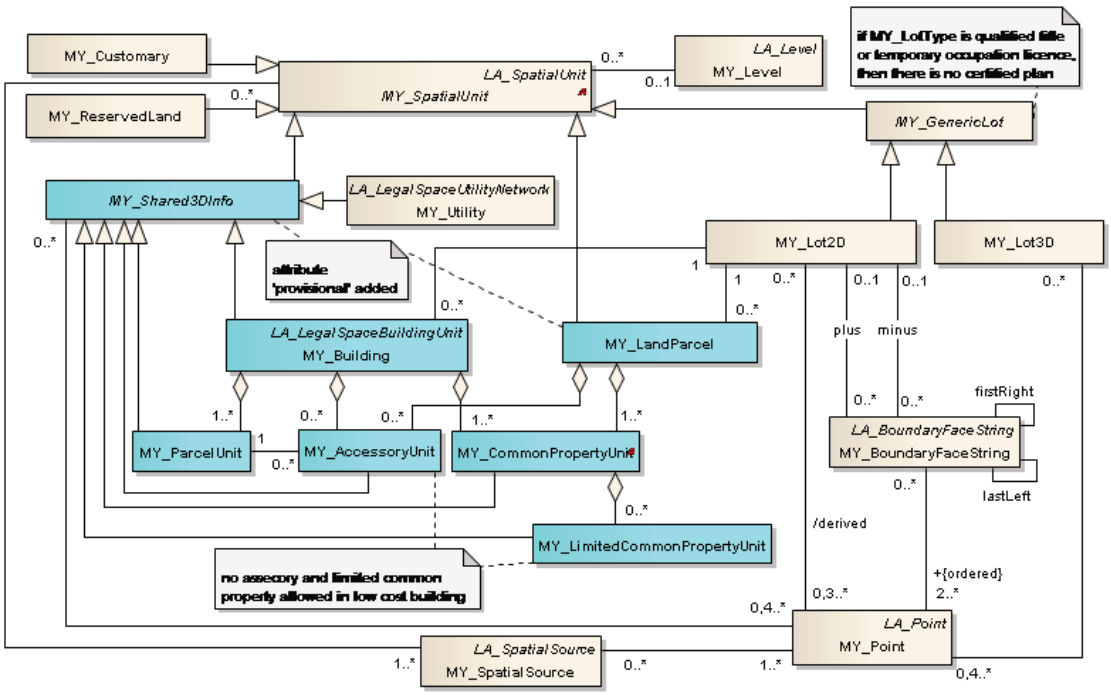

Figure 2. Overview of spatial part of Malaysian LADM country profile (darker colour indicates strata classes)

In the 3D spatial unit, topology is not used: not for lot (MY_Lot3D), nor for strata objects. In the model one strata object type remains to be represented in 2D, MY_LandParcel (with building no more than 4 storeys). The other strata objects are all proposed to be 3D and therefore inherit from an abstract class MY_Shared3Dinfo, with strata specializations (and mutual aggregation relationship): MY_BuildingUnit, MY_ParcelUnit, MY_AccessoryUnit, MY_CommonPropertyUnit and MY_Limited CommonPropertyUnit. As there can be several LimitedCommonProperty's in one CommonProperty, this is modeled as a part-of relationship to MY_CommonProperty (the aggregation class).

There are several abstract classes in the Malaysian country profile as indicated in Italics (see Figure 2): MY_SpatialUnit, MY_Shared3Dinfo, MY_GenericLot. These classes are only supporting the modelling process, representing shared attributes and structures, and these abstract classes will not get any instances (and therefore no corresponding table in the database implementation). For MY_Shared3Dinfo there is a geometry attribute (of type GM_Solid). Normally the 3D geometry in LADM is represented in LA_BoundaryFace, but given the fact that no 3D topology is used there is 1-to-1 association with the spatial unit (one of the specializations of MY_Shared3Dinfo). So, it could be argued that the proposed country profile is ISO conforming, despite that absence of the class LA_BoundaryFace.

The various types of spatial units are organized in levels. In this model, MY_Level class is used to organize the various types of spatial units. Basically, MY_Level is a collection of spatial units with a geometric or thematic coherence. The following levels are proposed: level 0 for customary, level 1 for reserved land, level 2, for 2D lot, level 3 for 3D lot, level 4 for strata and level 5 for utility.

Table 1. Example of IDs (UPIs) for lot and strata objects

Class	ID
Lot ('Normal' Spatial Unit)	04010800015662
Strata land parcel (building <= 4 storeys)	04010800015662(S)846(L)1
Accessory unit, outside building	04010800015662(S)846(A)1
Common property, outside building	04010800015662(S)846(C)1
Strata multilayer land parcel	04010800015662(S)846(B)ML1(M)0(T)ML1(L)1
Accessory unit, multilayer land parcel	04010800015662(S)846(B)ML1(M)0(T)ML1(A)1
Common property, multilayer land parcel	04010800015662(S)846(B)ML1(M)0(T)ML1(C)1
Strata multilayer land parcel (underground)	04010800015662(S)846(B)ML1(M)0(T)MLB1(L)1
Accessory unit, multilayer land parcel (UG)	04010800015662(S)846(B)ML1(M)0(T)MLB1(A)1
Common property, multilayer land parcel (UG)	04010800015662(S)846(B)ML1(M)0(T)MLB1(C)1
Building - main block (M)	04010800015662(S)846(B)M1(M)A
Building - provisional block (P)	04010800015662(S)846(B)P1
Parcel unit (inside building, condominium)	04010800015662(S)846(B)M1(M)A(T)1(P)1
Accessory unit, inside building	04010800015662(S)846(B)M1(M)A(T)1(A)1
Common property, inside building	04010800015662(S)846(B)M1(M)A(T)1(C)1

In case of spatial source documents (usually certified plans) there are links with spatial unit and point tables. MY_SpatialSource has association with MY_SpatialUnit and MY_Point. The Malaysian country profile uses suID for spatial unit and sID for spatial source. Basically, suID in Malaysian country profile is based on Unique Parcel Identifier (UPI). sID for spatial source is the certified plan number. Table 1 above shows some example values of IDs for each of the spatial unit types (i.e. lot and strata objects). For a more detailed explanation of UPI (see Zulkifli et al, 2013).

3.2 Administrative (legal) part

The legal part of Malaysian LADM country profile contains Party and Administrative package. Main class of the party package is MY_Party class with its specialisation MY_GroupParty. The administrative package concers the abstract class MY_RRR (with its the three concrete subclasses MY_Right, MY_Restriction and MY_Responsibility), MY_Mortgage, MY_BAUnit and MY_AdministrativeSource.

A basic administrative unit (BAUnit) is an administrative entity consisting of zero or more spatial units (parcels) against which one or more unique and homogeneous rights, responsibilities or restrictions are associated to the whole entity as included in the Land Administration System. A BAUnit may play the role of a 'party' because it may hold a right of easement over another, usually neighbouring and spatial unit.

One of the important foundations of LADM is the fact that all information in the system should originate from source documents and that the association to the source document is explicitly included (Lemmen, 2012). In case of administrative source documents (usually titles) there are associations with right, restriction, (including mortgage) and responsibility (RRR) and basic administrative unit (BAUnit). MY_AdministrativeSource associates with MY_RRR and MY_BAUnit. The Malaysian LADM country profile uses sID for administrative source. Basically, sID for administrative source is title number.

Except source documents, all classes in LADM (and therefore also all derived classes in Malaysian country profile), are subclass of VersionedObject and inherit all the VersionedObject attribute. The class VersionedObject is introduced in the LADM to manage and maintain historical data. As source documents cannot change, only new source documents can arrive, they are not versioned. This is a significant change because, the current land administration system in Malaysia does not yet support full history management. It is not only an important change for the land administration system itself, but it is also crucial for the future Malaysian information infrastructure, as others might need the functionality to refer to historic versions of land administration objects. Figure 3 gives an overview of the administrative (legal) part of Malaysian LADM country profile.

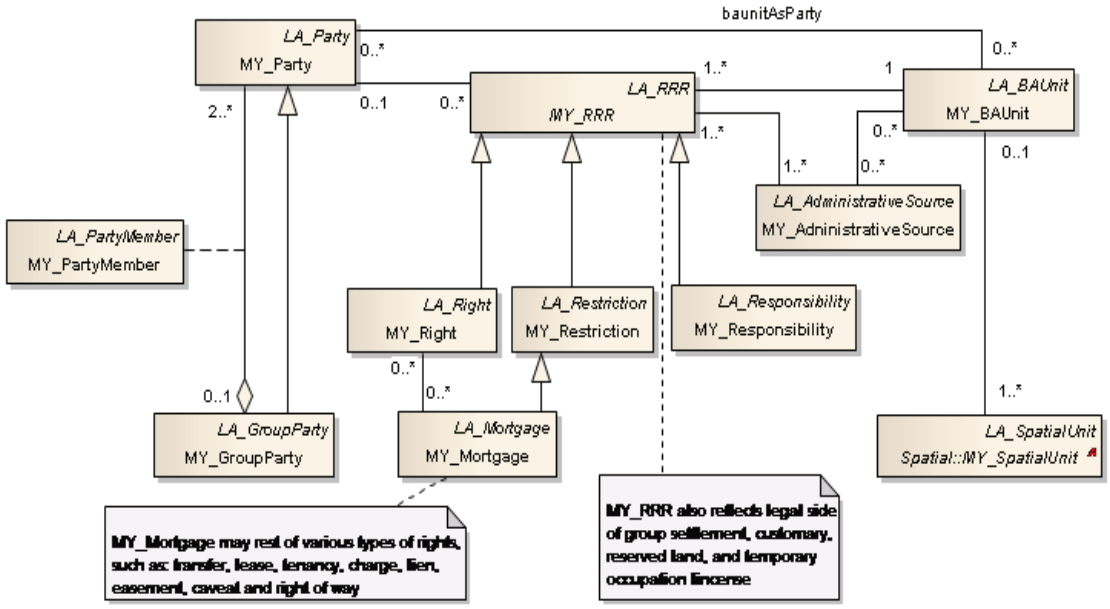

Figure 3. Overview of administrative (legal) part of Malaysian LADM country profile

4. TECHNICAL MODEL

Some sample data from Department of Surveying and Mapping Malaysia (JUPEM) and land office are converted into the technical model (Zulkifli et al, 2014b). Database construction is based on Oracle spatial where the study area is located at World Youth Foundation (WYF) building in the state of Melaka and some land parcels around the building. The WYF is a commercial building with four storeys and is used for 3D strata objects registration system.

MY_ParcelUnit represent 3D strata volume objects (e.g MY_ParcelUnit) are stored by multipolygon method (GTYPE = 3007). Oracle spatial also has a solid type (GTYPE = 3008), which in theory is preferred above the multipolygon for handling the solid type, but only available in more reference versions of Oracle spatial, therefore the multipolygon was used instead (which will also work on older versions). Figure 4 shows how to create table and store 3D strata object data using Oracle spatial.

```
CREATE TABLE MY_PARCELUNIT (
suid varchar2(73) primary key,
sid varchar2(25) REFERENCES my_spatialsource(sid),
lid varchar2(25) REFERENCES my_level(lid),
dimension varchar2(5) REFERENCES la_dimensiontype(cid),
type varchar2(5) REFERENCES my_parcelunittype(cid),
area_m2 dec(7,3),
volume_m3 dec(10,3),
geometry mdsys.sdo_geometry,
begin_date_time timestamp,
end_date_time timestamp);

-----------------------------------------------------------------------------------------------------------------

INSERT INTO MY_PARCELUNIT VALUES (
'04010800015662(S)846(B)M1(M)1(T)1(P)1',
'PA(B)42350-01',
'04010800015662(S)846(B)M1(M)1(T)1(P)1L4',
'DT04',
'CBU7',
'206',
'803',
MDSYS.SDO_GEOMETRY(3007,24571,NULL,
MDSYS.SDO_ELEM_INFO_ARRAY(
1,1003,1,
16,1003,1,
31,1003,1,
46,1003,1,
61,1003,1,
76,1003,1),
MDSYS.SDO_ORDINATE_ARRAY(
23763.508701,12534.314343,0.193868,23763.508701,12534.314343,0,23763.238999,12534.084021,0,
23763.238999,12534.084021,0.193868,23763.508701,12534.314343,0.193868,23763.238999,12534.084021,0.193868,
23763.238999,12534.084021,0,23764.154808,12533.005249,0,23764.154808,12533.005249,0.193868,
23763.238999,12534.084021,0.193868,23764.42451,12533.235571,0.193868,23764.42451,12533.235571,0,
23764.154808,12533.005249,0,23764.154808,12533.005249,0.193868,23764.42451,12533.235571,0.193868,
23763.508701,12534.314343,0.193868,23763.508701,12534.314343,0,23764.42451,12533.235571,0,
23764.42451,12533.235571,0.193868,23763.508701,12534.314343,0.193868,23764.42451,12533.235571,0,
23763.508701,12534.314343,0,23763.238999,12534.084021,0,23764.154808,12533.005249,0,
23764.42451,12533.235571,0,23764.42451,12533.235571,0.193868,23763.508701,12534.314343,0.193868,
23763.238999,12534.084021,0.193868,23764.154808,12533.005249,0.193868,23764.42451,12533.235571,0.193868)),
'01-JAN-14 10:15:30.26',
'');
```

Figure 4. Create table and insert data in MY_ParcelUnit table using Oracle

After loading sample data, the prototype frontend development is based on Bentley Microstation. Using this application, the query is conducted via the visual SQL Query Builder. The required functionality for assessing the model includes:

i. styling specifications (colour, linetype, etc.)
ii. styling and drawing specification for 3D simple feature geometry, eg. MY_ParcelUnit.
iii. zooming and panning in 3D displayed map
iv. making (SQL) selection based on spatial condition
v. 3D editing of simple geometry feature with versioning

Bentley Microstation is used to visualise the geometry and query using SQL. This prototype has limited functions and only covers small area for the assessment of the Malaysian LADM country profile. Initial result of the prototype for 3D strata objects registration as illustrated in Figure 5.

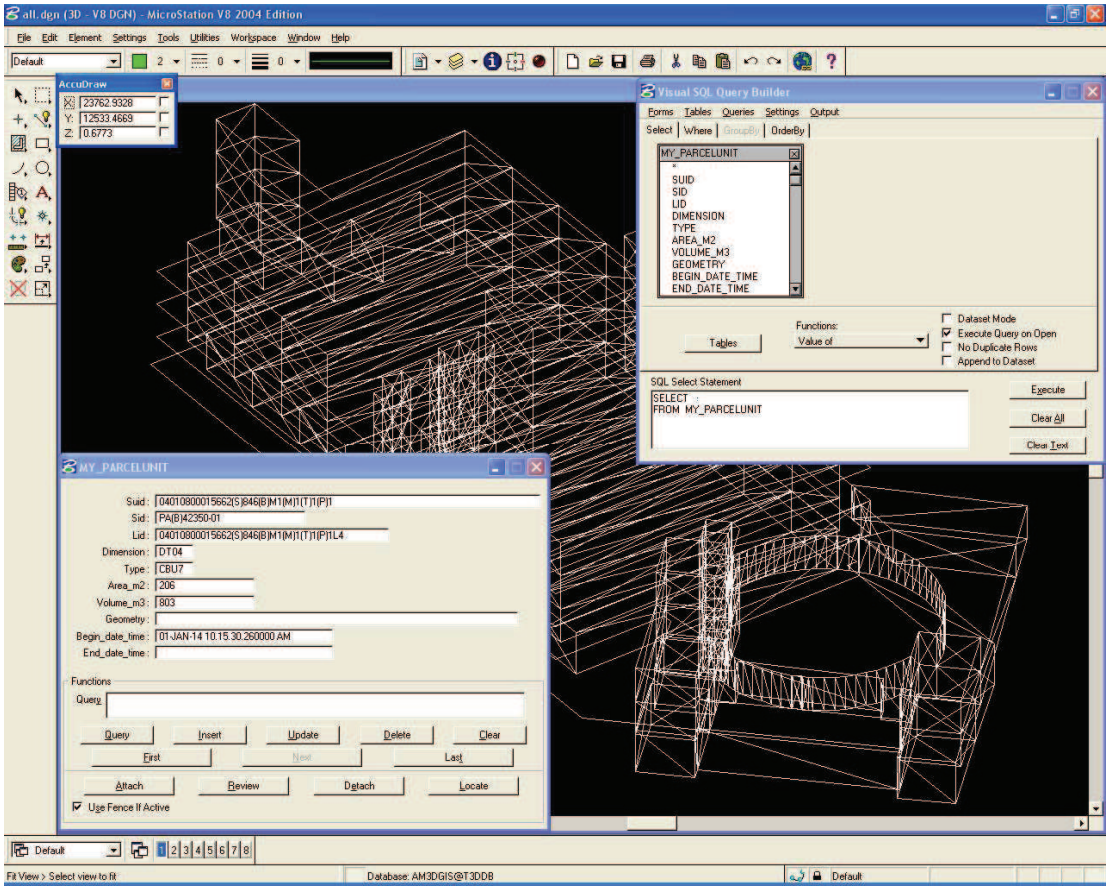

Figure 5. 3D data query and visualization of MY_ParcelUnit using Bentley Microstation

5. CONCLUSION AND RECOMMENDATION

This paper describes the 3D strata objects registration within LADM framework. Several novel aspects for the Malaysian land administration are introduced, such as: 3D representations (for building units and option for lots), full version management and inclusion of historic information, explicit linking of all land administration information and source documents (titles, certified plans), possibility to group multiple spatial units in one basic administrative unit with same rights attached, and legal spaces around utilities (in 3D). The future work includes investigation on the potential use of 3D topology for building to represent the various units within the building that share faces instead of giving each unit its own 3D geometry which can duplicating the shared faces between neighbours in the database storage.

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BIOGRAPHICAL NOTES

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Alias Abdul Rahman is a professor at the Department of Geoinformation, Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia (UTM), Skudai, Johor in Malaysia. He received a degree in Surveying and Mapping Sciences from North East London Polytechnic, England, UK in 1987, Postgrad Diploma in GIS from ITC, Netherlands, and MSc in GIS also from ITC, Netherlands. In 2000 he received his PhD degree from University of Glasgow, Scotland, U.K. He currently leads the Geospatial Information Infrastructure Lab at UTM.

Peter van Oosterom obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, the Netherlands. In 1990 he received a PhD from Leiden University. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, he is professor at the Delft University of Technology, and head of the 'GIS Technology' Section, Department OTB, Faculty of Architecture and the Built Environment, Delft University of Technology, the Netherlands. He is the current chair of the FIG Working Group on '3D Cadastres'.

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