

# **LADM Implementation Prototype for 3D Cadastre Information System of Multi-Level Apartment in Indonesia**

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**Key words:** LADM, 3D Cadastre, UML CASE Tools, Information System

## **SUMMARY**

Limitations of land supply for infrastructure developments in urban areas led to the development of multi-level and vertical buildings. Massive developments and uses of high rise buildings and constructions such as multi-level apartments and overpass structures in big cities in Indonesia indicated that the demand for space above the ground surface is rapidly increasing in recent years. Regardless the existence of policy and standards of services on land and property registrations, the trend will potentially cause ineffective space management as there is no dedicated information system to efficiently and effectively register and manage information related to boundary of property objects and spaces above the ground and their corresponding rights of ownerships and uses. This paper is dealt with a development of an information system prototype that deals with the registration and management of objects and spaces related to cadastre system (3D cadastre) . Currently the registration system does not store geometry and attributes of ownerships of spaces of property objects in a single system whereas there is a potential opportunity to adopt Land Administration Domain Model (LADM) basic classes in enhancing registration and visualization of land and property spaces. For that reason, a prototype was built based on a simple implementation of LADM basic classes by conforming to the national law on strata title for multi-level apartment and regulation of national land office related to land registration systems. This research uses 3D spatial data stored in CAD format of commercial units in multi-level building in city of Semarang. Enterprise Architect UML CASE Tools 9.3 is used to create a spatial database schema concerning the implementation of LADM basic classes suited to strata title registration system. PostgreSQL with PostGIS spatial extensions were applied to store geometries and attribute data. Delphi programming language with its GLScene components are chosen as the framework to build the prototype that enables 3D spatial data visualization. This research successfully created a desktop-based 3D cadastral information system prototype called SIK3D. SIK3D complies the terms of land administration system which mandates that the system should facilitate data input, processing, and visualization of land parcels and related spaces with their corresponding uses and ownership rights. Through the system, LADM basic classes can be adapted to the apartment's space ownership registration system that currently is regulated in Indonesia according to the Law. No. 20/2011 on Strata Title for Apartment and Executive Order of Land Office No. 1/2010 on land registration systems.

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## **1. INTRODUCTION**

Population growth and infrastructure developments in urban areas have extended the utilization of spaces. The space uses are not merely on top of the land parcels anymore, but towards the space above and below the earth's surface. Limitations of land supply for housing and infrastructure developments in urban areas led to the development of multi-level and vertical buildings.

Massive developments and uses of high rise buildings and constructions such as multi-level apartments and overpass structures in big cities in Indonesia indicated that the demand for space above the ground surface is rapidly increasing in recent years. Regardless the existence of policy and standards of services on land and property registrations, the trend will potentially cause ineffective space management as there is no dedicated information system to efficiently and effectively register and manage information related to boundary of property objects and spaces above the ground and their corresponding rights of ownerships and uses.

The key for successful management of uses and ownerships of property objects and spaces above the ground and their corresponding uses and ownerships rights is the availability of reliable information system. Such information system is expected to be able to handle information related to 2D and 3D geometries and their corresponding attributes that reflect complexities of rights, restrictions and responsibilities of 3D objects. Land Administration Domain Model (LADM) is an international standard that provides basic classes including 2D Spatial Unit and 3D Spatial Unit as well as RRR which are applicable to facilitate 3D property objects registration and visualization for land and space registration (Lemmen et al., 2010). LADM offers a conceptual scheme of the land administration system that covers a parcel (2D) and space (3D). Basic classes of LADM components are used as conceptual references for enhancing good land governance principles in 3D cadastre system prevailing in Indonesia. For this purposes, Law on Multi-level Apartments and Strata Title (Act No. 20/2011) (Anonim, 2011) and standard services on land registration systems (Land Office Executive Order No. 1/2010) are used as technical references (Anonim, 2010).

Law on (multi-level) apartment regulates the opportunity to build, manage, and use of apartment buildings. It defines that an apartment building consists of: common objects, common room and apartment room that can be owned by individuals or parties. It regulates the principles on the acquisition and registration of ownership rights of apartment rooms. Meanwhile land office standards on land registration services provides guidelines on technical implementation on a standardised set of services in every land offices in Indonesia in providing survey, right registration, right transfer, etc. In this context, the research was looked only at services related to strata title services, which are:

1. multi-level apartment property space/property identification;
2. ownerships right registration;
3. ownership right transfer;
4. (temporal) right extension.

Based on the description above, this paper deals with the development of a prototype of 3D cadastre information system that is capable to facilitate the registration of multi-level property spaces using LADM principles and according to national law and services standards. The property objects used in this study were commercial units located in a Plaza in the center of Semarang City called Simpanglima Plasa. The units in this multi-level building are entitled to strata title ownerships. The paper will explore the use of LADM basic units and use of Delphi, PostGIS to manage spatial data and attributes for supporting registration and visualization of multi-level apartment by implementing the principles depicted in the current law and executive order related to strata title registration of property objects. In the context of LADM validation for Indonesia context, previous work has been developed a prototype to assess cadastre implementation according to LADM classes (Sucaya, 2009). However the work has not been looking at 3D space ownership. Meanwhile in the context of 3D cadastre prototype evaluation, the previous work (Aditya et al., 2011) is only focused on visualization aspect and not utilising on the existence of national regulation and international standards.

Section 2 will elaborate materials and steps used in order to develop the prototype. Here principles in system modeling according to LADM classes and corresponding steps to utilise Delphi and PostGIS in order to realize the prototype will be discussed. Section 3 will provides steps on the development of the prototype and it will discuss the result. Section 4 will conclude the study.

## **2. METHODS**

### **2.1 Research materials**

The data used in this study consist of spatial data of 3D geometries of Simpanglima Plasa Building, Semarang in digital format. The data was produced from field survey and design plan validation resulted from joint study between the Department of Geodetic Engineering at Universitas Gadjah Mada (UGM) and National Land Office in 2011. Subsequently, the attribute data regarding individual space utilization in the building of Simpanglima Plasa were obtained from the management unit of the Building.

### **2.2 Research tools**

The tools used in this research include the hardware and software. The software used include AutoCAD Map 3D 2011 for editing and making a 3D object and also Google Earth Extension for AutoCAD to convert 3D spatial data dwg to kml format. Autodesk 3DS Max 2009 was used to change the spatial data format from CAD format into 3DS format. FWTools was used to convert data from KML format (Keyhole Markup Language) into spatial geometries stored in PostgreSQL PostGIS. Enterprise Architect version 9.3 is used as a UML CASE tool to create conceptual and logical models in the form of class diagrams, then generated into a PostgreSQL DBMS applications in DDL format. PostgreSQL with PostGIS spatial extensions

used to manage geometry and attribute tables. Delphi 7 is used to create an application user interface with the support of GLScene as a library for visualizing 3D object.

## **2.3 Prototype development processes**

### **2.3.1. Data Collection**

As mentioned earlier, the data were produced from field survey and drawing plan validation activities done by National Land Office and UGM. The data was available in CADformat whereas the attribute data was available in papers.

### **2.3.2. Data Processing**

The main data processing activities involve the development of solid model out of CAD survey data previously gained. For this purpose, firstly the CAD files (export file) were converted as KMLformat using GoogleEarth Extension for AutoCAD. Secondly, CAD data were converted into 3DS using 3DSMax 2009.

#### *Data Modeling*

The model development phase includes the identification on the compliance of LADM basic classes with the Law on Apartment. Further, a conceptual model that describes classes of 3D object ownership registration system and their linkages was drawn. The conversion from conceptual into logical model was done using the Enterprise Architect version 9.3 software as a UML CASE Tools. The schema was then implemented and populated using PostgreSQL with PostGIS extension. DDL is executed on the SQL editor in the DBMS software into a physical data model of spatial database for 3D cadastre information system. The classes that exist in the conceptual model were then realized in the form of geometry and attribute tables. PostGIS stored geometry data of this study as multipolygon Z type.

#### *System Design*

The system was intended to facilitate four standard of services in apartment/flats units (strata title) as mandated in The Executive Order of Chief of Land Office No. 1/2010, as mentioned in Section 1. The system was also intended to be used easily by typical land office operators when dealing with the typical of four types of registration services. User interface design was created using Delphi 7. Figure 1 shows the structure of the interface design of the designated 3D cadastre information system. In general the user interface facilitate registered users to do :

1. deed/certificate checking (exploring the survey and attributes data);
2. ownership right processing (first registration and transfer);
3. ownership right transfer.

Guests could use the application but it will be limited to search and view only capabilities.

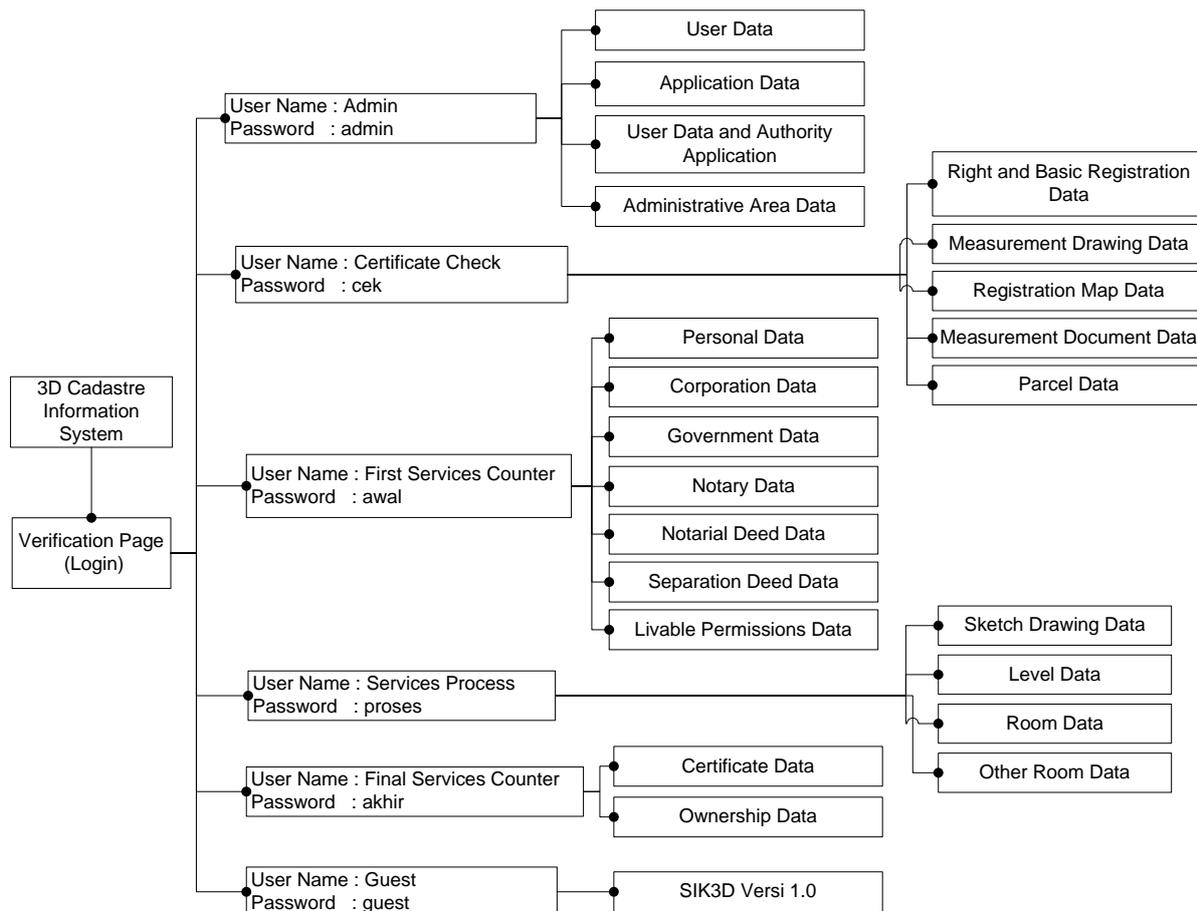


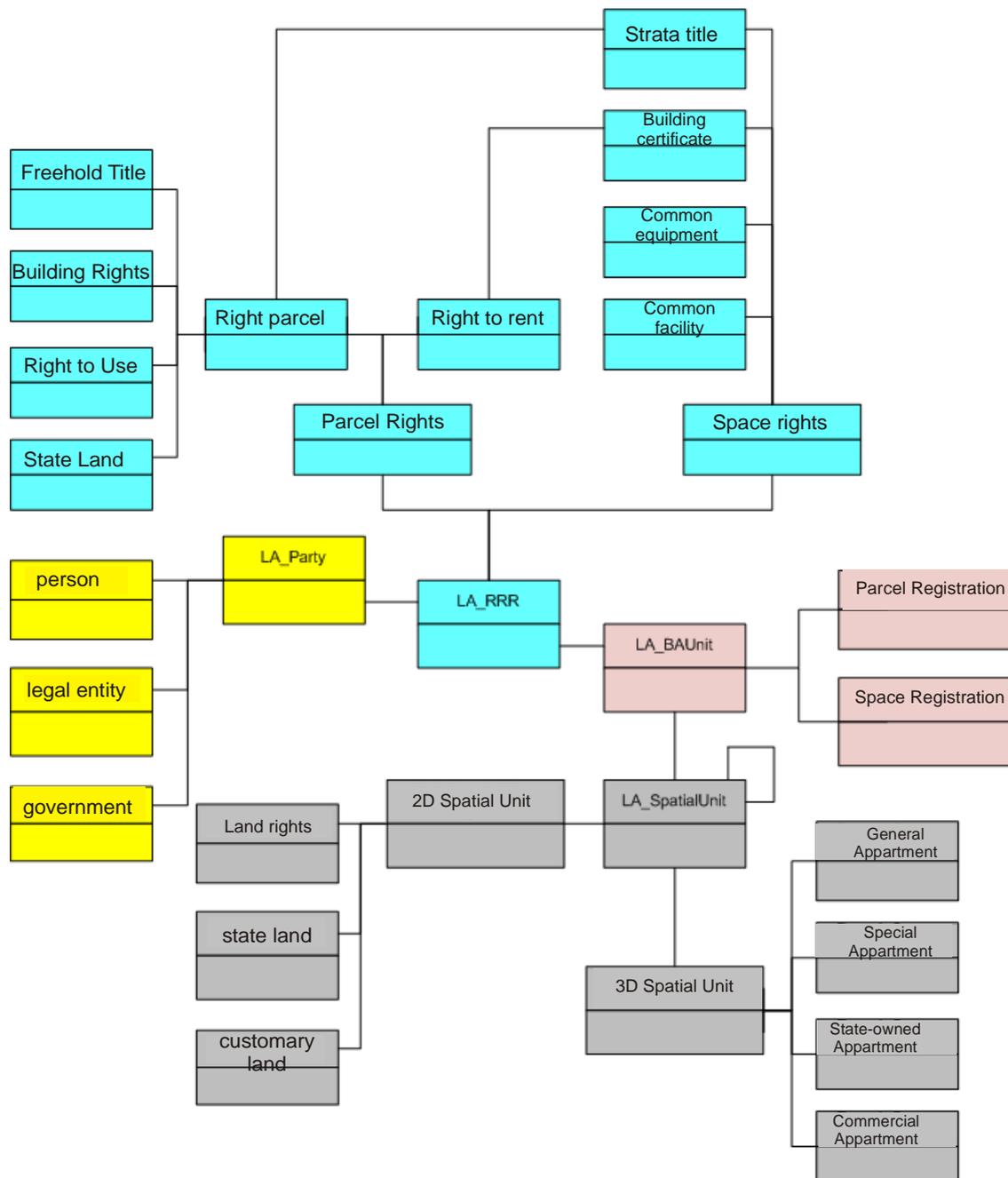
Figure 1. Structure of interface design of 3D Cadastre Information System

### 3. RESULTS AND DISCUSSION

#### 3.1 Data models

The data used in this study consist of spatial data of 3D geometries of Simpanglima Plasa Building, Semarang in digital format. The data was produced from field survey and design plan validation resulted from joint study between the Department of Geodetic Engineering at Universitas Gadjah Mada (UGM) and National Land Office in 2011. Subsequently, the attribute data regarding individual space utilization in the building of Simpanglima Plasa were obtained from the management unit of the Building.

The basic classes of LADM development model to the Law No 20/2011 on Apartment is presented in Figure 2. Figure 3 depicts the classess but it is organised in accordance with Executive Order of Land Office No. 1/2010 on service standards in land registration. From the logical modeling activity, it produces tables and the linkages between the tables utilised in the system, i.e. 3D cadastral information system (see Table 1).

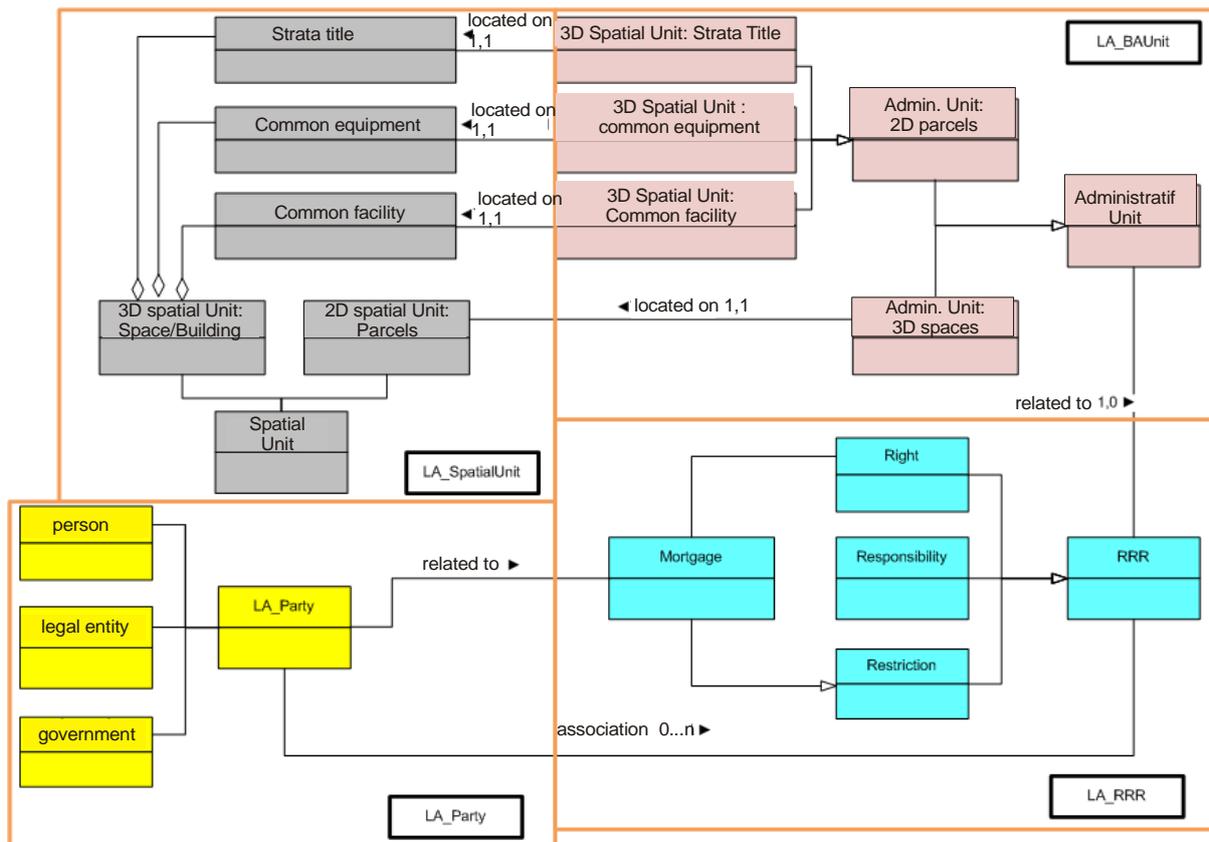


**Figure 2. Basic classess of LADM development diagram**

From assessing the Law and its conformance to LADM, here is a related description of the figure:

- a. LA\_Party is the ownership class that can be in forms of person, legal entity or government;
- b. LA\_RRR is developed towards parcel rights and space rights. Further, rights on parcels can be freehold and leasehold. Space rights can be in forms of strata title, building certificate, common facility and common equipment;
- c. LA\_BAUnita is registration system for 2D (parcel) and 3D (space);

d. LA\_SpatialUnit refers to objects to which the system register.



**Figure3. Conceptual model of spatial database for 3D Cadastre Information System**

Figure. 3 is considered as a conceptual spatial databases system conforming to the 3D cadastre information system designated. Enterprise rules for the schema is briefly given as follow:

- each parcel consist of one or many spaces;
- each space is located on a parcel;
- each right holder could have one or more spaces;
- each space is owned by a particular right holder;
- each right holder is connected to regulation and law concerning rights restriction and responsibilities attached to the objects;
- mortgage restrict right holder ownership rights.

The following is Table 1 that shows the high-level design of the spatial database that will be used in the system.

**Table 1. SIK3D spatial database table design**

No	Class	Object	Table Name
1	LA_Party	Personal Data Corporation Data Government Data	tb_perorangan tb_badan_hukum tb_instansi_pemerintah
2	LA_SpatialUnit 2D	Parcel Data Right and Basic Registration Data Measurement Drawing Data Measurement Document Data Data petapendaftaran Administrative Area Data : <ul style="list-style-type: none"> <li>• DesadanKelurahan</li> <li>• Kecamatan</li> <li>• Daerah tingkat II</li> <li>• Daerah tingkat I</li> </ul>	tb_bidang tb_asalhak_dasarpendaftaran  tb_gambar_ukur tb_surat_ukur tb_peta_pendaftaran  tb_desa_kelurahan tb_kecamatan tb_kab_kodya tb_propinsi
3	LA_SpatialUnit 3D	3D Spatial data geometry Room Data Floor Data Room Sketch Data	tb_geometri_ruang tb_ruang tb_tingkat tb_gambar_denah
4	LA_RRR	Separation Deed Data Livable Permission Data Certificate Data Ownership Data	tb_akta_pemisahan tb_ijin_layak_huni tb_sertifikat tb_kepemilikan
5	Legal_Aspect	Notarial Deed Data Notary Data	tb_akta_notaris tb_notaris

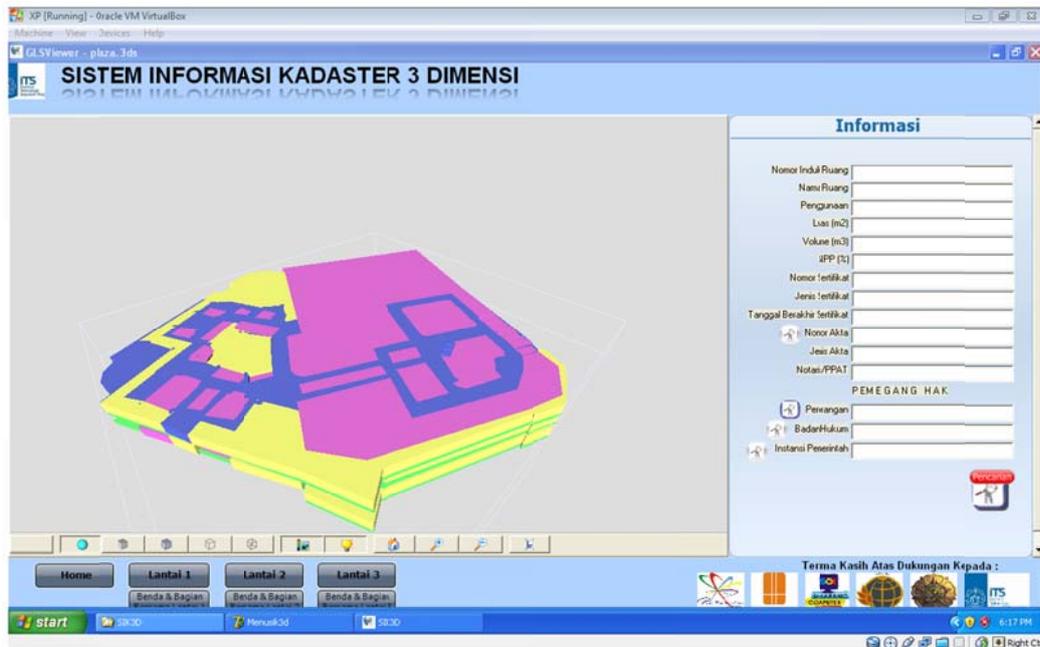
### 3.2. Prototype of the 3D Cadastre Information System

Prototype of the 3D Cadastre Information System is called SIK3D version 1.0. The prototype has functions that mainly to support registration and visualization regarding apartment objects and their corresponding ownership rights. LADM basic classes were implemented as the database tables that are used by the prototype. SIK3D has the functions as follow:

1. to facilitate users to check certificate which in action the prototype is utilising database tables on land certificates;
2. to facilitate users to use “FrontOfficeService” or "LoketLayananAwal" by identifying and uploading relevant legal documents attached to strata title (based on legal guidelines specified in the Law and Executive Order);
3. to facilitate users to process services by filling in the data in the tables related to the rights to the property objects or spaces in the apartment units;
4. to facilitate users to utilise “EndProductServices” that has main goal to link between the subjects (refer to LA\_Party that can be person or legal entity o government) and the property objects (corresponding boundary of object geometries and its related parcel).

The application has been successfully fulfill the requirements specified in the Executive Order on Service Standards. Thus, in reality the application is ready to be used by land office staff for registration and management of apartment ownership rights. In fact, targeted users (i.e. land office staff) mus log in fiest to be able to tun all aforementioned services. Without login into the application, any user can utilise the system in view-only mode. That means, users can not add, modify and delete data, but they can only do data discovery and visualization.

With regard to data visualization, the SIK3D prototype made use of GLScene for 3D visualization. 3D visualization of buildings and individual spaces are represented on UTM (Universal Transfer Mercator) coordinates. The objects can be scaled up and down, shift, and rotated on the display window according to users interaction. Information window is also available on request displaying attributes of selected geometries (figure 4). Figure 4 shows that SIK3D application is divided into two main parts, namely the visual and textual information section. However, north direction and scale information are not yet available at the moment.



**Figure 4. A screen capture of the SIK3D as the LADM implementation prototype**

Usability evaluation has been done involving four persons who are: Land Office staff at the city of Semarang, two persons from the management unit of Building of Plaza Simpanglima, one postgraduate student. Usability evaluation was done through structured interview after participants were asked to test the application. The questions in interview was about : (i) level of easiness on the use of prorotype, (ii) effectiveness of the prototype in facilitating apartment spaces' management including management of ownership information, (iii) about how the prototype gives clues and indication of errors in guiding the users completing the task, and (iv) about satisfaction to the user interfaces. The responses were ranked from 1 to 5 that corresponds to very bad to very good. The results of the test confirm that: the participants response positively (above 3,5) to all topics of inquiries given except for point (iii) that was 3,20. The results of usability testing confirm the usefulness of the prototype. The participants also encouraged that the application should be improved further.

#### 4. CONCLUSION

From the development of a LADM implementation prototype for 3D Cadastre information system of multi-level apartment, it can be concluded that:

1. the basic classes of LADM (Land Administration Domain Model) can be accommodated for a rights registration system of the space (3D cadastre) applicable in accordance to the Law. No. 20 year 2011 on Apartment and Executive Order of Chief of National Land Office No. 1 Th. 2010 on service standards on land registration. LA\_Party class comprises of Individual person, Legal Entity and Government Agencies as a right holder. LA\_RRR Class is implemented as a type of space rights referring to the deed and related documents specifying the status of the rights of ownership. LA\_BAUnit class refers to the procedures and rights registration system. LA\_SpatialUnit class refers to a 3-dimensional object (apartment/ flats units);
2. this study successfully implement a prototype of a desktop-based 3D cadastral information system by using the Delphi 7 Programming utilising PostGIS spatial databases that are created based on adoption of LADM basic classes;
3. The prototype, called SIK3D, has met the terms of service standards for strata title registration processing and visualization as well as to effectively link between the subjects and the property objects .

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## BIOGRAPICAL NOTES

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