The Conceptual Architecture for 3D Cadastral Data Management based on Land Administration Domain Model (LADM)

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Summary

Land information is needed to provide information to support sustainable development in Indonesia. 3D cadastre is needed because of population growth which increase infrastructures development both vertically and horizontally. Land Administration Domain Model (LADM) is an international standard for land information domain which support 3D cadastre. The main objective of the research is to see how far LADM and 3D cadastre can be implemented in Indonesian cadastral data management. The methods of this research are grouped into two main parts: analyze the requirements of cadastral data management and develop conceptual architecture of cadastral data management based on LADM.

KEYWORDS: LADM, land information, 3D cadastre, multi-purpose cadaster, cadastral data.

1. Introduction

Cadastre may be established for legal purposes, fiscal purposes, and allows sustainable development. Multi-purpose cadastre is increasingly seen as fundamental to economic development, environmental management, and social stability.

Cadastre in Indonesia are conducted by different institutions. Legal cadastre is conducted by *Badan Pertanahan Nasional* (BPN) with negative system, and fiscal cadaster is conducted by local government. These different institutions have their own separate database. Data sharing should be done between the separated system in order to support decision making for multi-purposes.

The implementation of 3D cadastre is very urgent in Indonesia. Arrangements are required to assure good governance in cadastral registration and to anticipate possible conflicts ensued from vertical developments.

Information system for cadastral data management is need a standard which comply data sharing and 3D cadastre. Currently, Land Administration Domain Model (LADM) become a standard which is used widely in the development of land information system. LADM is an international standard that provides basic classes including 2D spatial unit and 3D spatial unit as well as RRR (right, restriction, responsibility) which are applicable to facilitate 3D property objects registration and visualization for land and space registration (Lemmen et al., 2010). LADM is proved to be valid for the implementation in Indonesia (Sucaya, 2009).

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2. Research Methods

This research aim is to see how far Land Administration Domain Model (LADM) and 3D cadastre can be implemented on cadastral data management for multi-purposes in Indonesia. This is expected to be implemented for better cadastre system in Indonesia. This research has been carried out under six phases. Systematic implementation of this research will be carried out by the following procedures.

Firstly, reviewing the existing 3D cadastre system and cadastral data management in Indonesia.

Secondly, identifying the requirements of cadastral data management.

Thirdly, designing the conceptual architecture of cadastral data management based on LADM. The design is made by considering the result of the review of current condition and requirements analysis. This process contains the identification of classes and attributes of LADM based on requirements analysis, modification of LADM, and develop the physical model.

Fourthly, validating the proposed conceptual architecture. The proposed design will be verified by using simulation of prototype programming and will be assessed based on identified requirements. The simulation is done by query test on the physical model.

Fifthly, drawing conclusions and future initiative.

3. Requirements Identification of Cadastral Data Management (CDM)

The main purpose of requirements identification is to develop a system, which is accepted and supported by its users. The results of requirement identification comprise two matters, which are information and transaction needs. There some requirements that are identified, such as it is needed datasets that have to be managed in order to support sustainable development (land registration, property, tax, landuse, etc), it is needed the development of identifier for 3D cadaster to be used as common unique identity that can create linkage between different institutions (data sharing), and it is needed sufficient infrastructure development.

4. The Proposed Conceptual Architecture for 3D Cadastral Data Management

Conceptual architecture of cadastral data management is developed in the form of geodatabase design. Generally, the impact of data on system structure and procedure complexity cause geodatabase design has significant influence on the quality of CDM.

The LADM is a standardized cadastral data model which consists of classes and attributes. LADM is conceptual schema which is organized into three packages and one subpackage. According to the analyses to LADM classes and legal cadaster in Indonesia, classes and attributes in land registration activities can be defined into classes and attributes in LADM of Indonesian Country Profile. The conclusion of the translation classes can be seen in Table 1.

Table 1 **The relation between LADM and land registration activities**

Class in LADM	*Class in Land Registration Activities*
LA_Party, LA_GroupParty	• Land Owner (people, organizations), • customer
LA_BAUnit	Basic property unit
LA_RRR, LA_Right, LA_Restriction, LA_Responsibility	Right
LA_SpatialUnit	Parcel, 2DBuilding, 3DBuilding
VersionedObject	VersionedObject
LA_Source, LA_AdministrativeSource LA_SpatialSource	Application, AdminDocuments, SurveyReports

Some classes and attributes in LADM should be added. The purpose of these suggestion is to give reliable support of cadastral data management to meet the requirements. Based on requirements analysis, there are nine main class and nine code list classes. The main classes to support 3D cadastre are *ina_parcelblock*, *ina_buildingunit* and *ina_pef_unit*. While the code lists are *ina_parcelblock (code list)*, *ina_buildingunit (code list)*, *ina_parcelunit (code list)*, *ina_equipment (code list),* and *ina_facility (code list).* There are also other suggested classes which are related to data sharing requirement. Particularly, the classes related to detail party information, taxation, building permit, and landuse in Indonesia. The classes for detail party information are *extparty* and *extaddress*. The taxation classes are *exttaxation*, *exttaxtype (code list)*, and *exttaxspecialmark (code list)*. The building permit class is *extbuildingpermits.* The landuse classes are *extlanduse* and *extlutype (code list).* The classes of *ina_spatialsource* and *spatialsource_type (code list)* are classes which comply digital documentation on land registration.

As based on the suggestion classes and attributes, the UML diagram of LADM Country Profile Indonesia is modified. The complete UML diagram of modified LADM Country Profile Indonesia can be seen in Figure 1.

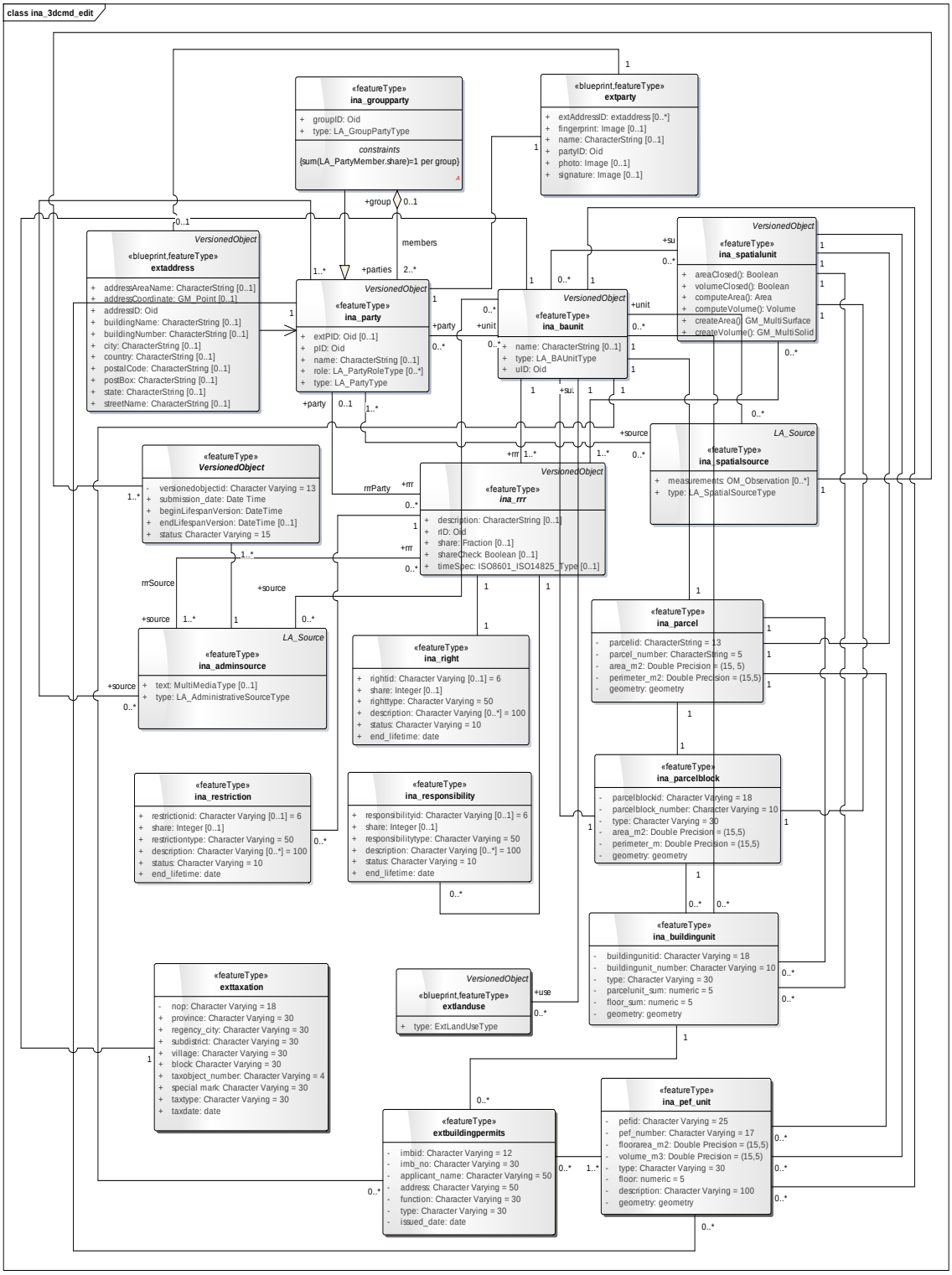

Figure 1 Class Diagram of Modified LADM Country Profile Indonesia

The code list class that are used in the modified LADM Country Profile Indonesia can be seen in Figure 2 (including the new suggested class).

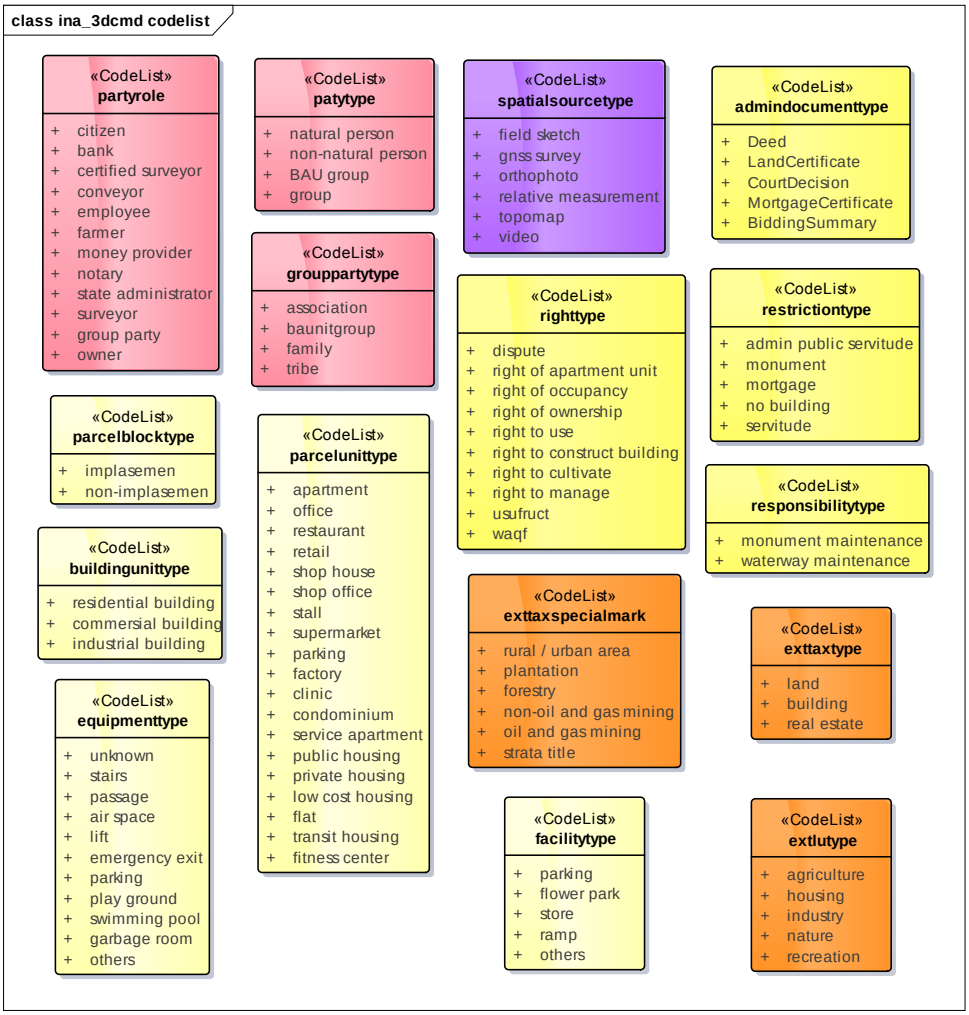

Figure 2 Code lists of Modified LADM Country Profile Indonesia

5. Verification of the Proposed Conceptual Architecture

There are several tests that are performed to verified the proposed conceptual architecture. The first test is to verified that the spatial data (2D and 3D) can be queried and visualized. The tables that are tested are *ina_parcel* and *ina_buildingunit*. The test results are the visualization of 2D and 3D data can be displayed integratedly with the attribute table and by selecting the land parcel/building unit, the information of the parcel/building will be displayed automatically.

The second test is to verified that the building unit can be queried with non-spatial data for multi-purposes. As for the tables that are included in this test are *ina_buildingunit*, *exttaxation*, and *extbuildingpermits*. Figure 3 shows that the query result displayed the 3D visualization and attribute table (building, taxation, and building permits information) integratedly.

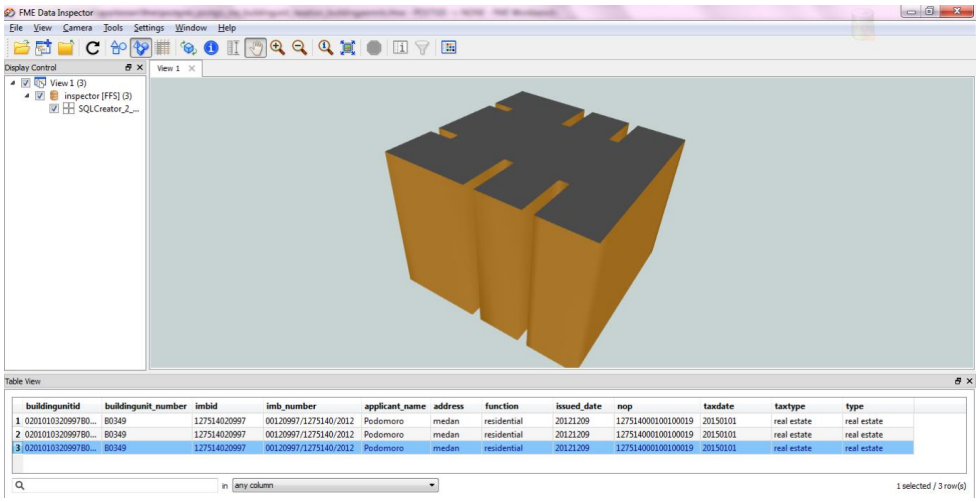

Figure 3 Query on Tables *ina_buildingunit, exttaxation,* and *extbuildingpermits*

The third test is to verified that the parcel unit in strata title plan can be queried with non-spatial data for multi-purposes. As for the tables that are included in this test are *ina_pef_unit*, *exttaxation*, and *extbuildingpermits*. Figure 4 shows that the query result displayed the 3D visualization and attribute table (parcel unit, taxation, and building permits information) integratedly.

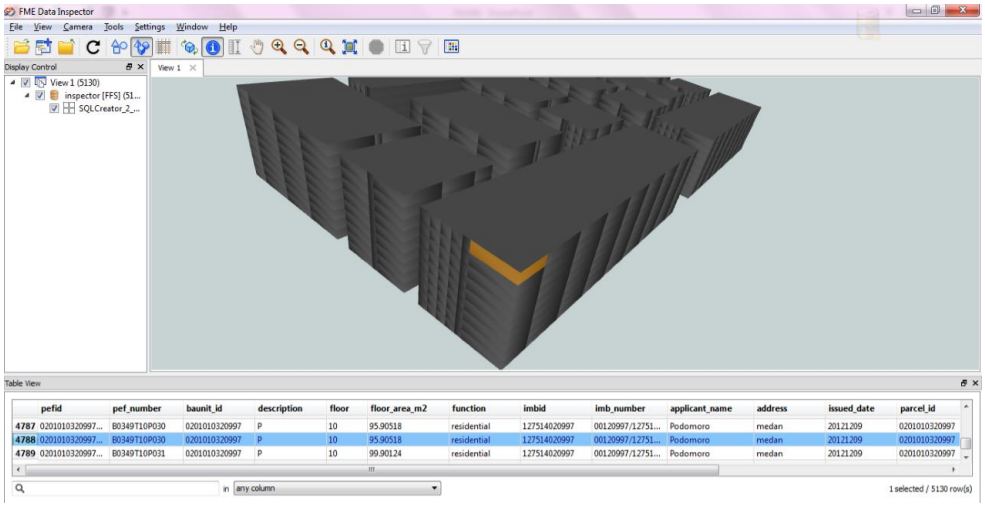

Figure 4 Query on Tables *ina_parcelunit, exttaxation,* and *extbuildingpermits*

6. Conclusions

Based on the results and the analysis which have already been described, there are some conclusions that can be made.

1. Refering to conceptual architecture that is proposed, LADM provides standardized class names for spatial and non-spatial data. For spatial data class, LADM has its own standard name called spatial unit. In this research, spatial unit is divided into two parts, which are land parcel (2D) and building unit (3D). Building Unit is also divided into three divisions (PEF unit). PEF_unit is a combination of parcel unit, equipment unit and facility unit classes.
2. The verification of the proposed conceptual architecture is done by query process. Query 2D spatial object in this research is based on *ina_parcel* table. Meanwhile, *ina_pef_unit* is used to query the 3D spatial object. The *ina_party* and *ina_rrr* is used to query non-spatial data. Besides, NIB is also important to link between spatial and non-spatial data. It is also used to query data from spatial and non-spatial data. There are also some new code lists for spatial and non-spatial data that are proposed.

7. Biography

Sitarani Safitri received the B.E. and M.E. degrees from Institute of Technology, Bandung, Indonesia, in 2010 and 2014, respectively. Currently, she has been taking PhD program in Geodesy and Geomatics Engineering, ITB. Her main area of research interest is spatial data infrastructure. She is a member of Remote Sensing and Geographic Information Science Research Group, ITB.

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