ADOPTION OF THE LAND ADMINISTRATION DOMAIN MODEL IN MAKATI CITY, PHILIPPINES

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ABSTRACT:

Land Administration is needed to provide sustainable development of a country as it is concerned with land tenure, use, value and development. The Philippines is challenged as it has multiple land agencies having different and redundant land administration systems. Initial initiatives to have a single land agency did not prosper but recently, two (2) major national land agencies: the Land Management Bureau and the Land Registration Authority are initializing land information system linkages and data sharing. Local government units (LGU) in the Philippines are also mandated to perform land administration functions. It covers functions related to land use, value, development, and partially with land tenure.

The Land Administration Domain Model (LADM) can be used in the improvement of the land administration system of a country. It has been adopted by several countries worldwide and has been a subject of many academic researches. However, only few researches were done related to the adoption of LADM in the Philippines. With this research, LADM was used to integrate the land administration system functions of an LGU, specifically the City of Makati, Philippines. The results show that LADM can be adopted in the study area. Adoption done by the researchers was limited to two-dimensional classes with proposed additional external classes not included in the original LADM.

1. INTRODUCTION

Land is a scarce resource that needs to be managed carefully to obtain a certain level of sustainable development of a country. This can be achieved if there is an efficient land administration. Land Administration includes all processes of recording and communicating information related to functions in land tenure, land use and land value (UNECE, 1996). Enemark (2009) included land development as the fourth function of land administration. These land administration processes or systems are infrastructures that facilitate the implementation of land policies that include social, economic and technical frameworks (Enemark, 2009).

Land administration systems are handled by a single agency or several agencies depending on the culture and government structure. Indonesia’s National Land Agency or BPN is a lone agency handling cadastral mapping and titling (Schreiber & Schneider, 2017). In Malaysia, cadastral system is handled by two (2) agencies namely the Department of Director General of Lands and Mines (DDGLM) and the Department of Survey and Mapping Malaysia (DSMM) (Zulkifli, et al., 2021). The Philippines on the other hand consist of at least five (5) agencies dealing with land titling, land surveys and maintenance of land information system such as the Department of Environment and Natural Resources Land Management Bureau (DENR-LMB), the Department of Justice -Land Registration Authority (DOJ-LRA), Department of Agrarian Reform (DAR), the National Commission on Indigenous People (NCIP) and the judiciary specifically the Regional Trial Courts (Dealca, 2009).

There are several agencies dealing with the different aspects of

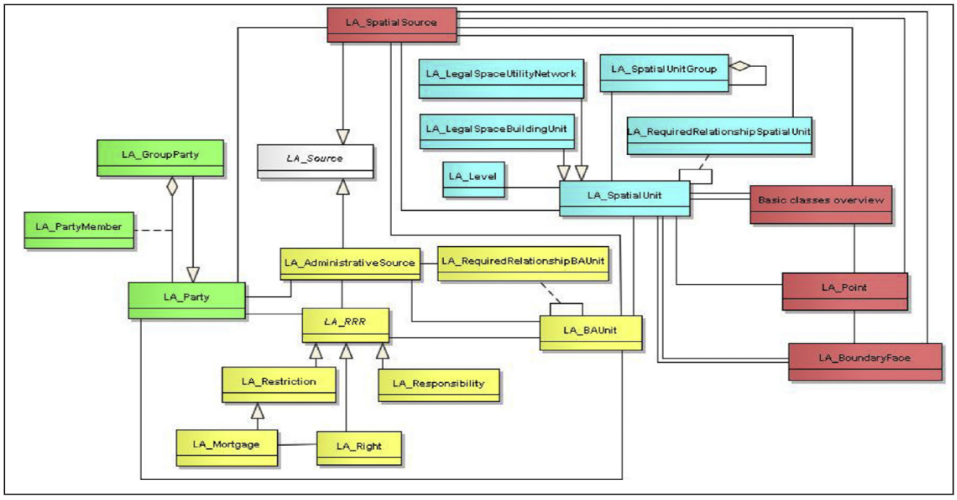

Figure 1. The Land Administration Domain Model (Lemmen & Rohan, 2015).

land administration. The Department of Finance-Bureau of Internal Revenue (DOF-BIR) and the assessor's offices of the 1,488 municipalities and 146 cities commonly called local government units (LGUs) deal with taxation. Sixteen (16) agencies dealing with land valuation (Philippines-Australia Land Administration & Management Project, 2002).

Mandates/Functions	Agencies involved	Source of duplication/overlap
Primary classification of public land as A&D land	DENR/NAMRIA; NCIP	Conflict between responsibilities for land classification as determined by EO 292 of July 1987 (instituting the Administrative Code), and the Indigenous Peoples Rights Act (IPRA) 1987.
Undertaking of land surveys for titling purposes	DENR (LMB); DAR; Potentially NCIP	Administrative Code provides authority to both DENR and DAR to undertake land surveys. IPRA 1987 gives NCIP responsibility for the identification, delineation, and recognition of ancestral lands/domains.
Approval of subdivision surveys for titling purposes (for land already titled)	LMB; LRA	Property Registration Decree (PD 1529 of June 1978, as amended) permits either LMB or LRA to approve such plans.
Award of original private rights in A&D land	DENR (Patents); DAR (CLOAs); Courts (court decrees); NCIP (CADTs)	Two titling processes (administrative, judicial), both mandated by law. Legislation authorizing different forms of ownership rights in land, by administrative process.
Maintenance of independent, uncorrelated versions of cadastral maps/records	DENR (LMB); LRA	A consequence of two agencies involved in two titling processes. The practice is neither explicitly mandated nor necessitated by law.
Compilation of land maps and information	Multiple agencies	A reflection of differing agency needs for land information, but some unnecessary overlap occurs.
Land valuation and related mapping for tax purposes	BIR; LGUs	Different valuation methods mandated by different property taxation laws.

Table 1. Summary of duplication of functions between land agencies in the Philippines. *Source: DENR-LAMP, International Management Policy Study, 2002 as cited by Dealca (2009)*

Agencies involved in land use planning and associated land use information include the LGUs, the newly formed Department of Housing and Urban Deelopment (DHUD) and the National Economic and Development Authority (NEDA). Land development function is handled by agencies such as the Department of Public Works and Highways (DPWH) and the LGUs specifically the Municipal/City Planning and Development Office and the Engineering Office. Different land agencies have their own land information systems (LIS), several of these already transitioned to computerized system with some still using analog/ paper-based system.

Multiple government agencies dealing with land administration was highlighted by Dealca (2009) as one of the problems in land administration and management including inefficient LIS.

Integration of land agencies, specifically the LRA and DENR-LMB, was attempted through the proposed Senate Bill 2776 or the Land Administration Reform Act in 2011. However, this did not prosper. In 2019, LRA and LMB signed a memorandum of understanding strengthening their partnership for public land titling (Land Management Bureau, 2019). Furthermore, the two agencies issued a joint memorandum circular initializing the linkage and data exchange between their LIS namely LAMS and PHILARIS (DENR-LMB; LRA, 2021).

LGUs (municipalities and cities), empowered by Republic Act 7160 or the Local Government Code of 1991, are tasked to administer and manage land in terms of use, value and development. It also issues documents needed for land titling process such as tax declaration and tax payment receipt. It also maintains an LIS either paper-based or digital. An LGU's LIS contains information coming from national agencies such as LRA and DENR usually provided by the client/ private owner and not necessarily directly and automatically obtained from the two mentioned land agencies.

Linkage or integration of different land agencies' LIS seemed to be the immediate solution to obtain an efficient and effective tool that can be used by the different land administration systems in the Philippines. However, the development of a complete country profile in the Philippines requires the inclusion of the rest of the national land agencies (NGA). This requires deeper study and understanding of the complex relationship and mandates of these NGAs.

Because of this, an alternative strategy is proposed to improve land administration and management in the country. This is to provide a suitable data model in the development of an LGU's LIS that can support the LA improvement initiatives at least per municipality/ city level. The simpler linkages and relationship between local offices in an LGU compared to NGA makes this strategy more feasible. The research is also significant as there are few published researches that dealt with the study of an LGU's data model in the Philippines. Furthermore, the initial outputs with the necessary improvements can be replicated by the rest of the LGUs in the country.

ISO 19152 or The Land Administration Domain Model (LADM) is an international standard that can be used to avoid re-development of a data model. This is the basic template in the development of a local data model for an LGU.

The objectives of the research are to study the land administration system being implemented by an LGU specifically Makati City in the Philippines, provide a localized data model of LADM in conformity with the land administration system of the said LGU and validate the suitability of LADM in the local setting.

2. REVIEW OF RELATED LITERATURE

2.1 Land Administration Domain Model

LADM is a standard reference model that can be used as basis for the development of an efficient land administration system and enable involved parties to communicate based on shared concepts implied by the model (Lemmen & van Oosterom, 2011). It provides a methodology for classification and formal language for land interests (Paulsson & Paasch, 2015).

The model expressed in UML (shown in Figure 1) having three (3) main packages: LA_Party, LA_RRR and LA_SpatialUnit in green, yellow and blue colours respectively, and with sub-package: Representation and Survey in colour red.

An LADM edition II (LADM 2) was presented by Lemmen, et al. (2021) at the FIG e-Working Week 2021. Improvements in the LADM include additional packages such as Land Registration, Marine Space Georegulation, Valuation Information, Spatial Plan Information, and Support for Implementation (Lemmen, et al., 2021).

2.2 LADM Implementation

LADM has been implemented worldwide in different modalities showing its flexibility in meeting land administration needs (Chipofya et al., 2020). Around forty (40) countries have adopted, with different modality and levels of implementation, an LADM-based country profiles (Kalogianni, et. al., 2021). Lemmen et al. (2020) reported, at the World Bank Conference on Land and Poverty, twenty-three (23) of these countries' LADM-based country profiles in terms of cadastral system status, mapping with LADM classes, conceptual model developed, conformance level test, technical implementation, and development initiators. Some experiences in the implementation of LADM of these countries are provided below.

LADM started in The Netherlands earlier known as the Core Cadastral Domain Model (CCDM) (Hespanha, et. al, 2008) developed by Dr. Lemmen and Dr. van Oosterom in 2006. It evolved into the LADM after six (6) years of discussion with land administration professionals and the development of an International Standard for the Land Administration Domain (Lemmen, 2012). Recently, the Netherland's Cadastre, Land Registry and Mapping Agency known as Kadaster initiated a redesigning of cadastral information with better cadastral geometric quality and new information system based on LADM (Hagemans, et al., 2022). Kara, et al. (2019) proposed the Netherlands LADM Valuation Information Model Country Profile. Valuation related classes were added as extension of the LADM and is part of the improvement proposed in LADM 2.

In Turkey, initiative projects such as the Turkey National Data Infrastructure with GIS (TUCBS) and the Land Registry and Cadastre Information System (TAKBIS) were implemented to provide cadastral integration based on international standards (Alkan & Polat, 2019). Alkan and Polat (2019) compared the the approaches used in the development of TUCBS and TAKBIS relative to LADM and concluded that they are in conformity. Polat & Alkan (2018) also highlighted the need for an external data management in conformance with the LADM enabling data sharing between institutions such as the General Directorate of Land Registry and Cadastre (GDLRC) of Turkey and external institutions such as a municipality. A Municipal External Data Model was developed compatible with the External Archive Data Model of the LADM supporting the external data management of a municipality and online transfer of information to GDLRC (Polat & Alkan, 2018).

Kalantari & Kalogianni (2018) developed and presented an LADM-based Country Profile for Victoria, Australia. This was done by comparing the existing Victorian ePlan Protocol with the core LADM. Mapping of the two data models showed compatibility that provided the transition from ePlan classes to LADM-Based classes. However, it was pointed out that ePlan does not formally support the registration of 3D spatial units thereby highlighting the need for a revision based on LADM (Kalantari & Kalogianni, 2018).

Siriba & Mwenda in 2013 presented the initiatives in Kenya's land administration system to transition from a centralized system to a hybird system having both centralized and devolved systems. Similar to other countries' experiences, a comparison of the LADM with the existing land administration system was done paving the way in drafting an LADM-based country profile. In addition, Kuria, et al. (2016) presented a web-based LADM for Nyeri County, Kenya. An Africanized Land Administration Domain Model (A-LADM) was implemented demonstrating the importance of automating processes based on software development and stakeholder participation in the implementation of an LIS (Kuria, et al., 2016). Gender recordation and rights, community land rights and recordation, Pastoralists' season occupation of land, and informal occupation of land were issues seen as necessary inclusion in the extension of the A-LADM model (Okembo, et. al, 2022).

Tjia (2014) provided an in depth study of both national system of land registration and municipal systems of land administation for South Africa. It was concluded that the LADM provided an opportunity to improve the South African e-Cadastre and the City of Johannesburg Land Information System (CoJLIS).

In Colombia, Jenni, et al., (2017) highlighted a modular approach for the implementation of LADM based on the principle of legal independence for multi-purpose cadastre and model driven approach. Specialized models based on specific theme or institutional mandates were built around the core LADM. Specialized models included cadastre and registry, spatial development plans, protected areas, formalization, ethnic territories, and fallow land (Jenni, et. al., 2017). Lemmen, et al., (2020) reported the land administation modernization initiatives being done in Colombia. Automation efforts that considers the entire industrial processes and joint efforts of many government entities and stakeholders that provides data integrity and process simplification are part of Colombia's modernization efforts (Lemmen, et al., 2020).

Dos Santos, et al. (2013) explored the potential of LADM to Brazilian Urban Cadastre. The research emphasized that municipalities in Brazil have relatively organized cadastre that needs standardization or a deficient system that required a new structured system thereby rationalizing the need to study the viability of using LADM in Brazilian Municipalities' cadastres (Dos Santos, et al., 2013). LADM was applied to the cadastre of Arapicara City, Brazil. The study concluded that the LADM-based model for the study area showed potential for data sharing and integration of cadastres.

Lemmen, et al., (2020) reported that Indonesia has adopted and implemented LADM with three (3) dimensional visualization. Indrajit, et al. (2021) presented the next initiative which is to promote exchange of information between the land administration domain and spatial planning. The Spatial Plan Information Package (SP Package) of LADM 2 was proposed to be used and provided a proof of concept for the City of Jakarta and Badung. The study of Indrajit, et. al. (2021) showed that the SP Package can be used both by Cadastre agencies and local governments in a networked environment that includes RRR and zoning information.

Malaysia developed its LADM country profile in 2014 with a database design and development of a 3D cadastral registration prototype (Lemmen, et. al., 2020). Zulkifli, et al. (2021) presented an LADM-based 3D strata objects registration in Malaysia that includes database design and prototype development.

Although the Philippines is not part of the 40 countries eumerated by Kalogianni, et al. (2021) that developed an LADM-based country profile, Aranas, et al. (2014) utilized the use of LADM to to link the LIS of three (3) NGAs namely: DENR, DAR, and NCIP. The researchers studied the various land administration processes of the 3 agencies and mapped the different classes and compared to the LADM classes. In effect producing an initial LADM-based country profile. However, the

data model did not capture the rest of the NGAs’ LAS nor was it adopted/ used by the considered subject agencies.

2.3 LADM Localization Methodology

Local adoption of the LADM requires the development of a country profile. A country profile is a profile valid for the whole country consisting of bases standards and its identified clauses, classes, options and parameters necessary for accomplshing a particular function (Kalogianni et al., 2021).

Kalogianni et al. (2021) enumerated six (6) generic characteristics of country profile development based from the country background information. These are profile, scope, stakeholders involvement, status of existing LAS, 3D LA, and future LADM scope.

A roadmap to adopt LADM in cadastral information systems is proposed by Kalantari et. al. (2015). The stages of adoption includes organizational motivation, institutional management, information interpretaton, information organization, governance and engagement and capacity building (Kalantari et. al., 2015).

Kalogianni et al., (2021) and Kalantari et al. (2015) highlighted the involvement of stakeholders and the institution/government as basic requirement to successfully adopt and implement LADM.

Both researchers proposed analyzing the existing country LAS, information interpretation and information organization as strategies in relating the current country LAS to LADM. These can be done by mapping the attributes of the existing LIS to the LADM (Aranas, et al, 2014).

2.4 Model Validation Tests

Two validation tests were obtained from literature review. These are user-requirements and abstract test suite.

The UNECE (1996) Land Administration Guidelines requires the identification of end user-requirement to be done prior to any change or adoption of an LAS. This includes activities such as review of associated land policies, examination of current management structures and LIS, and the information needed by the LAS managers and users that should be present to the new system being introduced. The LADM conceptual data model are verified using the user-requirements (Sucaya, 2009).

Second is abstract test suite in conformance with ISO 19105. The test examines the proposed data model including the classes, attributes and associations against the corresponding definitions of the LADM model (ISO/TC211 Secretariat, 2012). The test is composed of three (3) level conformance tests low, medium and high conformance.

3. METHODOLOGY AND DATA REQUIREMENT

The methodology used in adopting LADM edition I to a subject LGU includes LAS Analysis, Comparison of local LAS data fields to LADM, localization of LADM and Model Validation as shown in Figure 2.

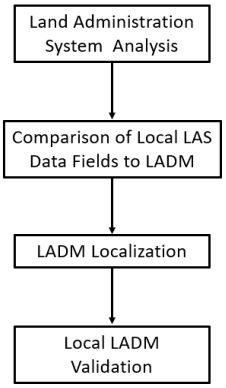

Figure 2. LADM adoption methodology.

3.1 Land Administration System Analysis

LAS analysis included activities such as familiarization with the subject land agency/ies. For this study, an LGU was selected as the main agency with the DENR and LRA as other source of land information.

Data gathering was done on cadastral data either digital or paper-based. This includes tax declaration from the LGU’s Assessor’s Office, land titles from the LRA, cadastral and survey plans from the DENR. Data fields and descriptions from the LA documents were examined. Data fields were enumerated from source documents. Further evaluation of the data fields was done which includes a check on the properly filled-up documents. Data fields that were not filled-up were purged from the list. A final local LAS data field list was produced. This list was further analysed taking into consideration the relationship between the stakeholders/ LAS process owners involved.

Interviews were conducted by the researchers to key personnel in the LGU to supplement information in building the model.

3.2 Comparison of Local LAS Data Fields with LADM Classes

The final local LAS data fields were compared and grouped to the LADM classes, attribute, value type. Data fields that are congruent or otherwise with the LADM were noted.

3.3 LADM Localization

Conforming local LAS data fields were assigned to classes and attributes based LADM. Data fields that did not fit to any of the LADM classes were placed to External classes. UML diagrams were used to visualize the localized LADM.

3.4 Local LADM Validation

Local land policies were researched and studied. Interview with LAS process owners were done to better understand the different land administration processes involved and the expected outputs needed by the users. In addition, the resulting localized LADM was presented to key personnel for further clarification and improvement. Model validation was done using user-requirements and abstract test suite. For the user-requirements test, the local LADM was tested if it met the list of needs provided by the process owners. The local LADM was also tested using the abstract test suite to assess if the data model meets ISO 19105.

4. STUDY AREA AND RESULTS

Makati City is part of the National Capital Region or Metro Manila. It is located at latitude 14d 33’ and longitude 121d

01’East. It is bounded at the north by Pasig River, on the east by the Municipality of Pateros, on the north-west by the City of Manila, on the south to south-west by the City of Pasay, and on the south-east by the City of Taguig. Figure 3 shows a map showing the location of Makati City relative to the rest of the National Capital Region and neighbouring provinces.

Figure 3. Vicinity map of Makati City. *Source: http://travelsfinders.com/manila-metro-map.html*

Three (3) offices of City Government of Makati are providing land administration services. These are the Urban Development Department under the Administrative Services Group, Assessment Department, and Office of the Building Official under the Infrastructure Development Group.

The Urban Development Department guide the utilization of the city’s land resources. It provides the spatial framework of the development of the city that guides the location, intensity and type of activities based on the zoning ordinance (City Government of Makati, 2022).

The Assessment Department discovers, classifies, and appraises real properties as basis for taxation. Its duties also include tax mapping and fair market values scheduling of the different classes of real properties.

The Office of the Building Official is mandated to issue building permits, notices to fix, building code compliance certificates. It has a duty to inspect all building works.

All the duties and functions of the three (3) offices are functions mandated by Republic Act 7160 to be the responsibility of each LGUs.

LAS/cadastral documents provided by the City of Makati are paper based which includes hardcopies of land titles, tax

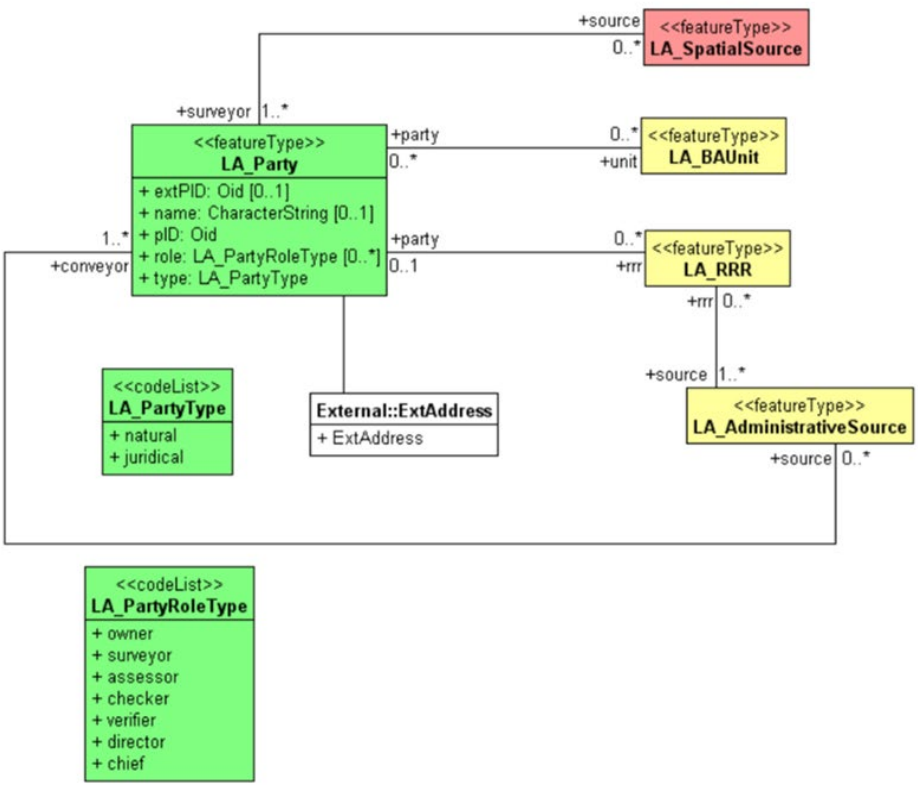

Figure 4. Localized classes of the Party Package.

declaration, tax map/ cadastral map and subdivision plan.

4.1 Localized LADM Classes

Figures 4 to 7 show the localized classes in the Party, Administrative, Spatial Unit Packages, and Surveying and Representation Sub-Package respectively with the colouring scheme adopted from the original LADM. External classes for each package are added if a certain local information is not found in the original LADM. These are coloured in white class boxes.

The Party Package includes persons involved in the LAS. It shows the owner/ claimant of the land, other persons such as the surveyor, survey checker/ verifier and those persons approving the documents. Also included in the proposed package are the assessor of property value for taxation purposes (See Figure 4).

The LA_PartyType includes natural person and judicial person that includes companies, corporations and firms recognized by law as legal entities. These are considered as legal entities that can own or claim land.

An external class, External::ExternalAddress is added to provide the documented address of the owner/ claimant which are found in tax declarations and even in land titles.

LA_RightType provides ownership including set or rights included in land ownership such as right to use, dispose to name a few.

LA_Responsibility includes the obligations of the owners/ claimants such as real estate tax, capital gains tax.

LA_BAUnit is the same for the localized model. It is associated to zero or more party holding the right for the whole unit, to zero or more spatial units and to one or more instances or rights, restrictions and responsibilities. The administrative source, associated to zero or more basic administrative units describe the rights, restrictions, and responsibilities that affect them. Lastly, basic administrative unit may be related to zero or more spatial sources.

LA_AdministrativeSource includes information that describe the Party, the corresponding RRR, and the basic administrative units concerned. It is associated to one or more parties, to zero or more basic administrative units and to zero or more specializations of LA_RRR. This class covered the titles and the tax declarations of real properties. The two (2) documents mentioned are included in the code list of LA_AdministrativeSourceType.

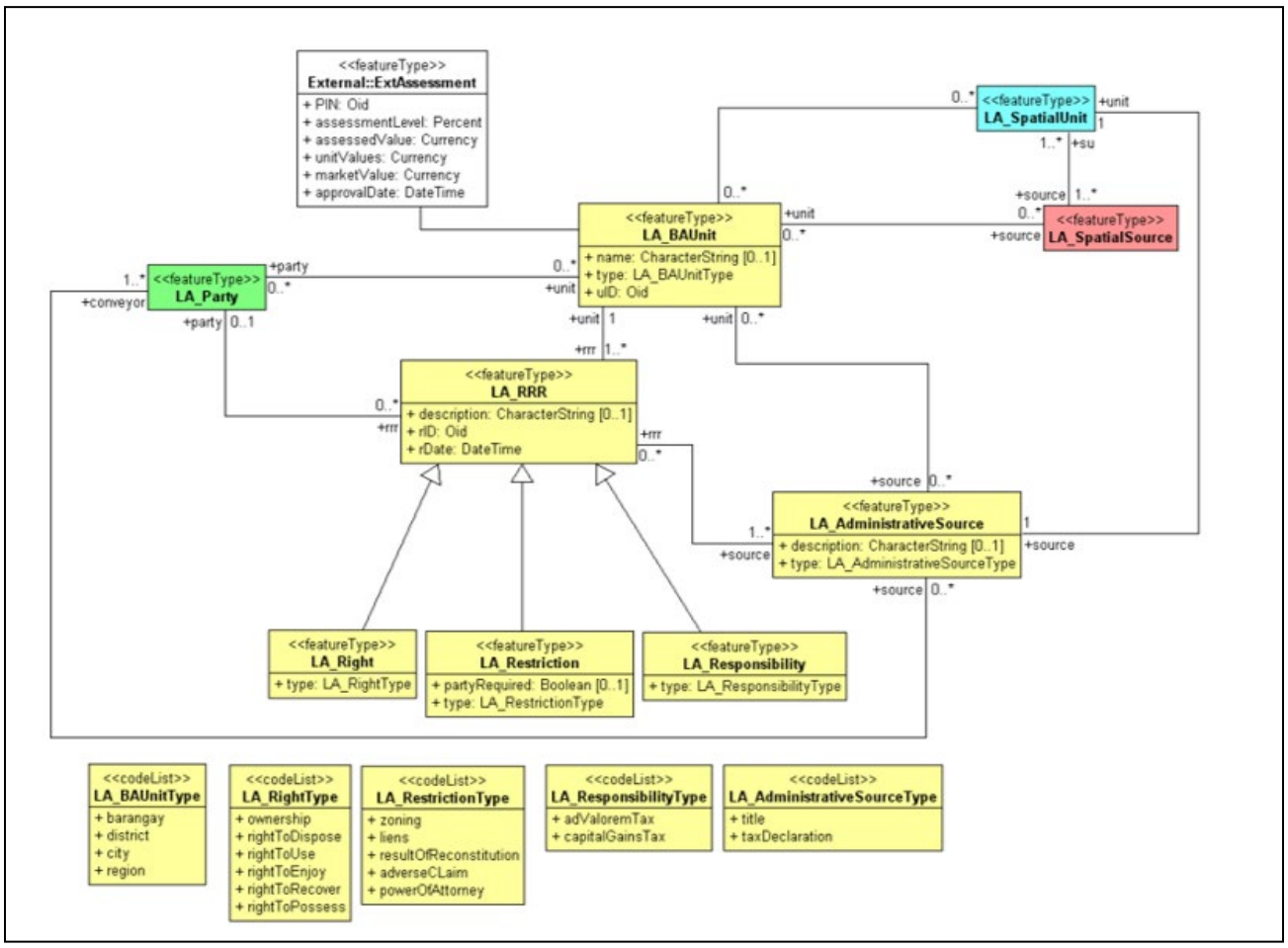

Figure 5. Localized classes of the Administrative Package.

The basic class LA_RRR from the original LADM remains the same. The instance of this class was associated to zero or one party but can be associated to one basic administrative unit. It can also be related to one or more administrative source (See Figure 5).

The added class External::ExtAssessment includes data such as PIN, assessment and market values, unit values and assessment level that did not correspond to any of the original attributes

associated to the original LADM. These attributes are needed in land assessment prior to taxation.

The proposed model adopted the original LA_SpatialUnit from LADM. This spatial unit can be a single land parcel owned/ claimed by a Party. It may be associated to zero or more basic administrative rights since it can be used to describe the extent of a basic administrative unit. The specialization of this class, the LA_LegalSpaceBuildingUnit was also provided (See Figure 6).

A spatial unit can consist of other spatial units creating a spatial unit group and the group can also be a part of a larger group. With this, the LA_SpatialUnitGroup is adopted since cadastral data and subdivision plans show that land parcels can be grouped such as blocks from complex subdivision.

value, value date, assessment level, assessed value and approval date. This external class is associated to LA_BuildingUnitType.

External::ExtLandUse and External::ExtLandUSeType are classes added to accommodate land use database from the city planning and development office needed by the assessment office.

All the classes in the sub-package are taken from the original LADM except for LA_BoundaryFace which is a three-dimensional information (See Figure 7).

The survey documents provided more details more than what is required in LADM. To accommodate additional data fields relevant in the local (Philippine) setting, the attributes of the classes in the sub-package are modified. No external classes are

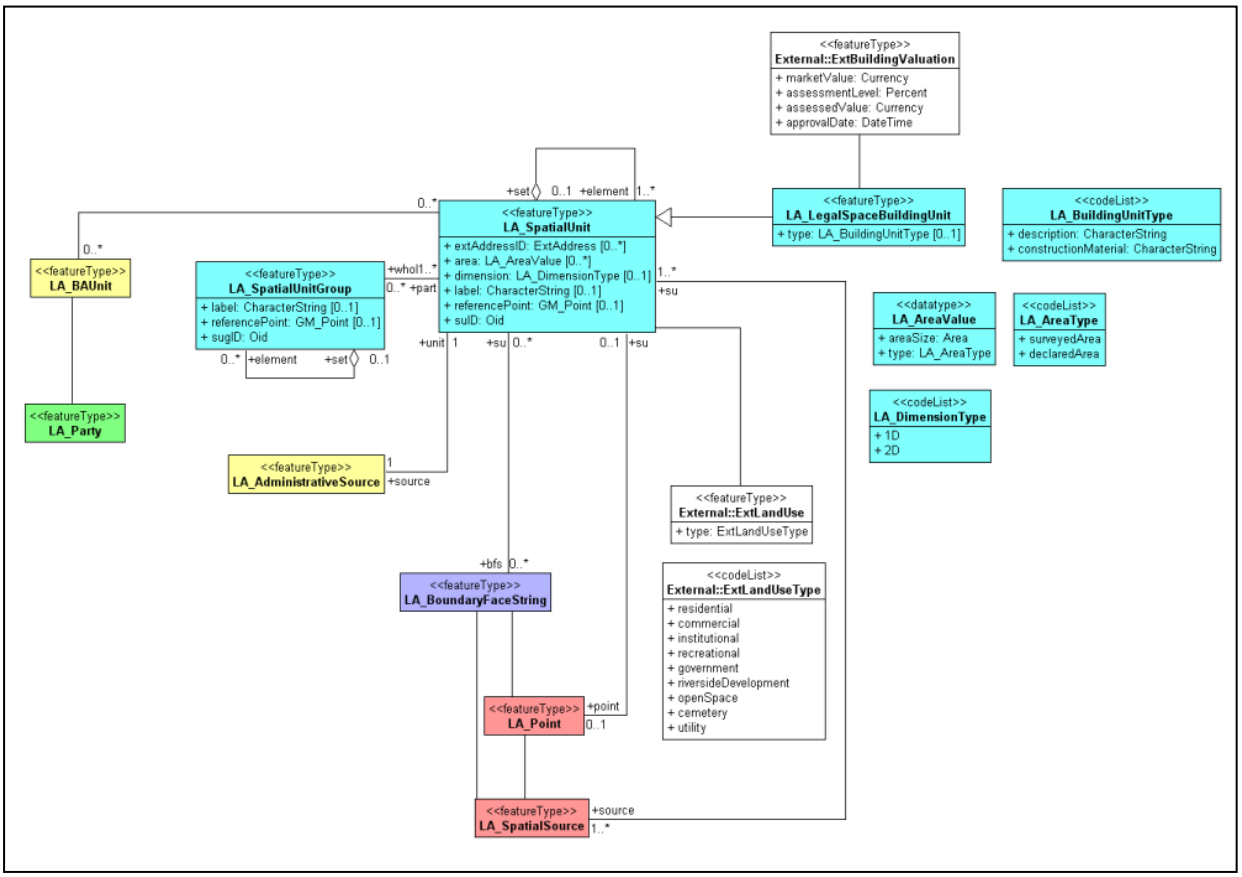

Figure 6. Localized classes of the Spatial Unit Package.

LA_Area includes the value of the land area based from the lot data computation and listed as the surveyed area under LA_AreaType. However, another land area value can be found in the land title and tax declaration.

LA_DimensionType shows the boundary described using point (one-dimensional) or line (two-dimensional).

LA_BuildingUnitType describes the type of building/ improvement on the land. This information can be useful for the assessment and taxation of improvements. However, the localized model did not accommodate any three-dimensional information.

External::ExtBuildingValuation is provided and can accommodate data fields from tax declaration such as building

proposed because these attributes serve as additional details for the existing classes. LA_Point and LA_SpatialSource are classes inherited directly from the original model.

A spatial source shows the spatial representation of a spatial unit. It is associated to one or more points as it describes those points used in the survey. It is associated to zero or more boundary face string to describe the boundary of the lot parcel. It can be associated to a basic administrative unit to describe the extent of the property. It is associated to one or more Parties because of the role of the surveyor.

LA_SpatialSourceTypes includes survey documents such as approved survey plans, cadastral maps, lot descriptions and lot data computations.

LA_PointType is identified to be the type of points used in the conduct of a land survey such as control/ reference points, lot corners and traverse stations.

LA_MonumentationType shows the different markings used to identify points on the ground.

LA_BoundaryFaceString can provide information such as the geometry of the boundary of a spatial unit described in terms of lines with distance and direction or points and physical objects.

LA_Transformation provides support to reference system transformation. Both grid coordinates and local coordinates are accommodated in this localized class.

a. Basic cadastral information must be readily available and efficiently accessed;
b. Functions of the different offices must be clearly defined in the context of services rendered regarding land administration;
c. Effective and efficient data sharing and data transfer.

The result of the user-requirement test shows that the basic cadastral information is provided by the localized LADM needed by the administrators and the clients. The attributes can provide the needed information and the association of classes show the relationship of each data.

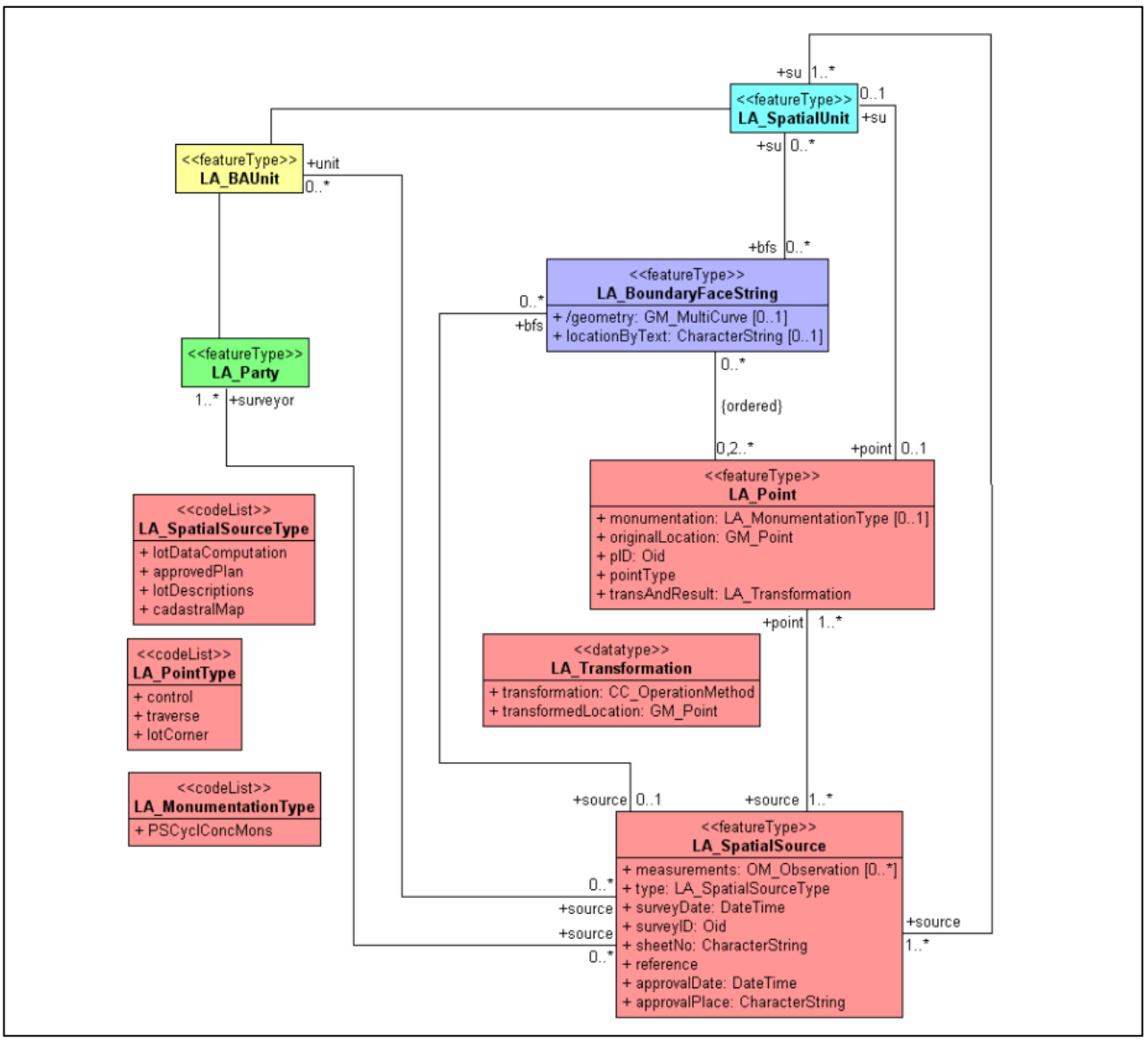

Figure 7. Localized classes of the Surveying and Representation Sub-Package.

4.2 Model Validation

The user-requirements were collected during the data gathering phase’s coordination with key personnel of the Assessor’s Office of the LGU. This became the basis if the localized LADM model can fit the users’ needs. The user-requirements are enumerated below:

Classes can be assigned and maintained by the Urban Development Department, Assessment Department, and Office of the Building Official. A department can be tasked to record, keep and update databases only to the classes assigned to it but can view the databases assigned to the other department therefore eliminating redundancy and overlap of functions.

Finally, since all data have defined association, data sharing can be possible and duplication/ redundancy can be avoided.

The resulting localized LADM was presented to the Assessment Department of Makati. The assessor noted that the localized LADM even if in the conceptual level was helpful as it presented a way to improve data sharing. However, it was also mentioned that there is a need for them to have further training to understand the diagrams provided and how to implement it. The assessor also saw the need for the local government to have the political will to implement change and improvement in the current LAS.
The result of the abstract test suit specifically using the test case identifiers. Results of the test showed that the localized classes are fully conformant to the requirement of Conformance Level 1 specifically LA_BAUnit, LA_Party, LA_Spatial_Unit, LA_Right, and VersionedObject.

The model was also tested for Conformance Level 2 using the classes LA_AdministrativeSource, LA_BoundaryFaceString, LA_Restriction, LA_SpatialSource, and LA_Point. LA_Point lacks the attributes compared to the original LADM class. LA_GroupParty and LA_Party Member were not included in the localized LADM. Therefore, the localized model did not pass Conformance Level 2. With these results, the local LADM produced is at low-level of conformity.

5. CONCLUSIONS AND RECOMMENDATIONS

Land administration is needed to implement land policies that strengthen sustainable use of land. A good LIS provides support to the implementation of land administration processes. LIS depends on a good data model that captures the different types of data, their relationship and the different processes involved. The LADM provides a template for such data model. This is a standard model being implemented by different countries at different modality and level.

A study on localizing LADM for an LGU was proposed as an alternative strategy other than producing a data model at the national level with multiple land agencies. This is also relevant since LGUs are also mandated through the Local Government Code of 1991 to perform land administration related activities. Researches by Kuria, et al. (2016), Dos Santos, et al. (2013) and Indrajit, et al. (2021) showed that LADM implementation can be done at the municipal or city level.

A localized LADM is produced based on the gathered cadastral documents and coordination with a number of personnel from the LGU. The results show that the LADM can accommodate the basic 2D LAS functions of the LGU specifically the City Government of Makati. The localized LADM is simple and provides terminologies that are being used by the LGU’s LAS.

Additional external classes were proposed to accommodate existing information that are not explicit in the original LADM. The provided UML diagram can be used in the development or improvement of a computerized LAS of the LGU. However, cadastral data used are limited and may not accurately mirror the overall LAS even at the local level. 3D based classes of the original LADM were not included in the localized version. Although the model passed the user-requirement test, it only passed the low-level conformity of the abstract test suite. Because of this, the localized LADM needs further improvement.

Much of the classes placed under the external classes in the localized LADM seemed to fit the packages under LADM 2, specifically the Valuation and Spatial Plan Information. It is therefore recommended that further study of LADM in the Philippines be done for the country to improve its land administration systems either at the national or local level or both considering LADM 2.

Finally, migration from the current system to an LADM-based LIS in support of the LAS modernization entails both the academe and government motivation and involvement. A complete LADM country profile for the Philippines at the national and local levels is still needed to solve or minimize the country’s land administration problems.

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