Land administration domain model: application to the City of Johannesburg land information system, South Africa

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Abstract

The aim of this paper is to explore the application of the Land Administration Domain Model (LADM) to the City of Johannesburg Land Information System. The LADM is a conceptual schema which is being developed by the ISO/TC211 for modelling the rights, restrictions and responsibilities affecting land and their geospatial and/or geometric components. The ultimate goal of this schema is to provide an internationally accepted vocabulary and common understanding within the domain of land administration. This is to facilitate the integration of information and systems through the introduction of a common standard model that is flexibly designed to allow for development of country-specific profiles applicable to specific jurisdictions and organisations. To test the applicability of the model, studies have been conducted in certain countries, regions and organisations. This paper presents the results of an empirical investigation undertaken to explore the LADM applicability to South Africa, using the City of Johannesburg as a case study. The case study was limited to the core property model of the LIS. Using the LADM as a reference schema. Although the model is applicable to the City of Johannesburg, it has a broader application to urban municipalities (i.e. towns and cities).

Keywords

land administration domain, land information system, City of Johannesburg, South Africa

Introduction

For many decades, cadastral systems have been known for their reliability and well-defined processes in support of security of private rights over land parcels and land markets. Simpson [1] describes the South African cadastral system as one of the best in the world. The system is known for its' highly accurate land surveying that is based on geodetic network of co-ordinates and conveyancing [2]. Although the system provides secure property rights for those who can afford it, like many in the world it has failed to secure the rights of many poor communities who leave under informal and customary land tenure arrangements [2]. South African land registration system is centralised with the offices of the Registrar of Deeds and the Surveyor-General office responsible for registration of real rights (including associated restrictions and responsibilities) over land and cadastral surveying respectively. The information systems of two offices are currently independent of each other with the legal conveyancing being predominately manual [3]. The current business model is said to be inefficient to meet current challenges. These include the need for optimal efficiency and accuracy of land parcel management of current and other forms of land tenure, which are not registerable in the current system despite their legal status in the government's land reform programme. The prerequisite for these is a consolidation of two databases held by the deeds and surveyor-general offices into an integrated information system [3]. In line with international cadastral reform efforts, South Africa has embarked a project named "e-Cadastre project" in line with its' e-government policy to develop an integrated system for management of land registration information (deeds and cadastral information). The project is aimed at optimizing efficiency and accuracy of land parcel management and to accommodate other forms of land tenure which are currently not accommodated in the registration system.

There is a need for research to identify solutions in developing a system of this nature. Research shows that cadastral systems, where prevailing, played an important role in economic development through the support of simple land markets. However, factors such as technological advancement, globalisation, social change, and business interconnection and population growth put pressure on these systems worldwide [5]. These factors have remained drivers for the reform of cadastral systems. One such area is in the development of a domain specific model for land registration and cadastre. The LADM is a conceptual schema, now in final draft, by ISO/TC211 for modelling basic land related information rights, restrictions and responsibilities affecting land and their geospatial and/or geometric components. This schema intends to improve the interoperability between cadastral or related information systems. This is aimed at enhancing land information exchange between various organisations (local, national and international) and information society as a whole. LADM is required for communication between land administration professionals and for system design, development and implementation [6]. It is also required for data exchange and data quality management purposes. The components of the model can be used to efficiently develop, implement and maintain systems of land registry and cadastre by involved organisations. The LADM can be implemented within one or over different organisations each with different tasks and responsibilities in the maintenance of specific land information.

Purpose of this paper

This paper presents the results of an empirical investigation undertaken to explore the LADM applicability to South Africa, using CoJ as a case study. The case study was limited to the core property model of the Land Information System (LIS). The choice of the CoJ case study area is motivated by the current CoJ initiatives (i.e. the Upgrade Project) to improve their LIS workflow to a fully integrated workflow application (software) that automates business processes whereby information or tasks are passed from one participant to another for action according to set procedures or business rules. The case study was limited to the core property model of the LIS. The study is part of an on-going research to develop a country profile of LADM for South Africa. The key underlying assumption for this paper is that the results presented in the CoJ case can be replicated in other municipalities of similar nature. The smaller urban municipalities may also use the result as framework to model their specific requirements. Municipalities deal with LA functions of that require identification of property ownership, allocation of rights of use, property valuation and taxation as required by the Municipal Property Rates Act [10]. The Act empowers all South African municipalities to collect revenue from property rates and taxes. This function relies on timely identification of properties (including boundaries); timely and accurate valuation of property; which in turn relies on the use of the property (zoning and land use as determined by various township planning ordinances); and billing of property and services.

Literature review

Land administration

In order to understand the Land Administration Domain Model (LADM), it is essential to first define land administration (LA). LA has numerous definitions. The United Nations Economic Commission for Europe (UNECE) defines LA as a process of determining, recording and disseminating information about land tenure, value, use and its associated resources when implementing land management policies [1]. However, there are other useful definitions. Dale and McLaughlin [2] offered a more specific definition: “land administration is the processes of regulating land and property development, the use, conservation of land, the gathering of revenues from the land sales, leasing, and taxation, and the resolving of conflicts concerning the ownership and use of land”. Land administration is broadly described in the ISO 19152, *Geographic information/Geomatics – Land administration domain model (LADM)* as a process of determining, recording and disseminating information about relationship between land and people [3]. All the definitions given have similarities. They are all describing LA as involving processes of generating information related to land. They all describe some form of relationship between humankind and land. This relationship may be factual as in the case of possession of a property (i.e. buildings) and legal as in the case of registered ownership, lease, or servitude over a farmland. A legal relationship between land and people is normally registered as a land registration system component of the land administration system.

Land administration has received much attention in modern literature. However its’ land registration systems, cadastral surveying, mapping components have a long history. Early cadastral records which date back to about 3000 BC existed in Ancient Egypt [2, 3]. In South Africa, a system of land registration which originated in the Netherlands during the thirteen and fourteen centuries was implemented in the Cape in the sixteenth century [4]. This system of Roman-Dutch law origin is described as one of the best in the world by some authors [2, 3, 4]. Some authors identified cadastral surveying, LIS and Geographic Information System (GIS) as the basic “information generating processes” in LA [3]. Cadastral surveying deals with delineating land parcel boundaries (either general or fixed boundaries) for purposes of real rights (ownership, servitude, leasehold) registration and others such as taxation or land development (subdivisions and consolidation of land) and land use regulation. LIS and GIS provide mapping and land resource information [3]. A land registration subsystem records rights, restrictions and/or responsibilities (RRRs) affecting land while LIS provides an enabling spatial and textual framework to record information related to the registration of the RRRs [5].

Land Administration Domain Model

Land Administration Domain Model (LADM) is an international standard data model being developed by the International Standardization Organisation (ISO) under Technical Committee 211 for Geographic Information/Geomatics. The LADM is a specific domain model dealing with that part of LA which deals with rights, restrictions and responsibilities (RRRs) and their geospatial and/or geometric information component [3]. The aim of this spatial domain model is to improve communication between various organisations through introducing standard concepts or vocabulary in the land administration domain. This is intended to improve interoperability between cadastral or related information systems, thus improving exchange of land information between local, national and international organisations and information society at large. The model is abstractly organised using the Unified Modelling Language (UML) into three basic packages: party package; administrative package; spatial unit package and sub-package of spatial unit: surveying and representation as illustrated in Fig. 1 and Fig. 2.

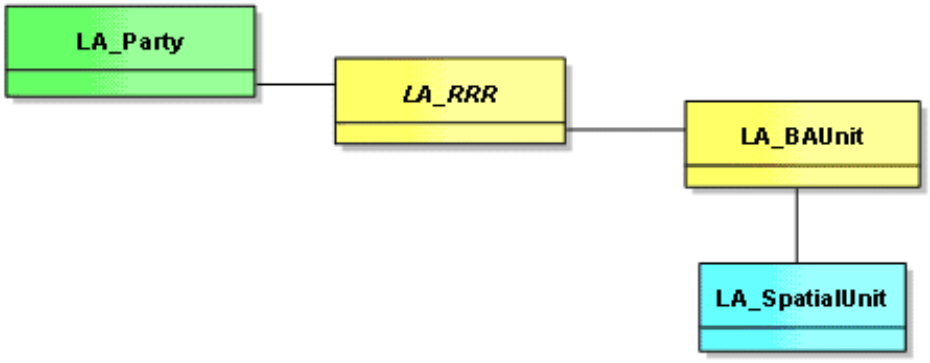

Fig. 1: Core LADM classes.

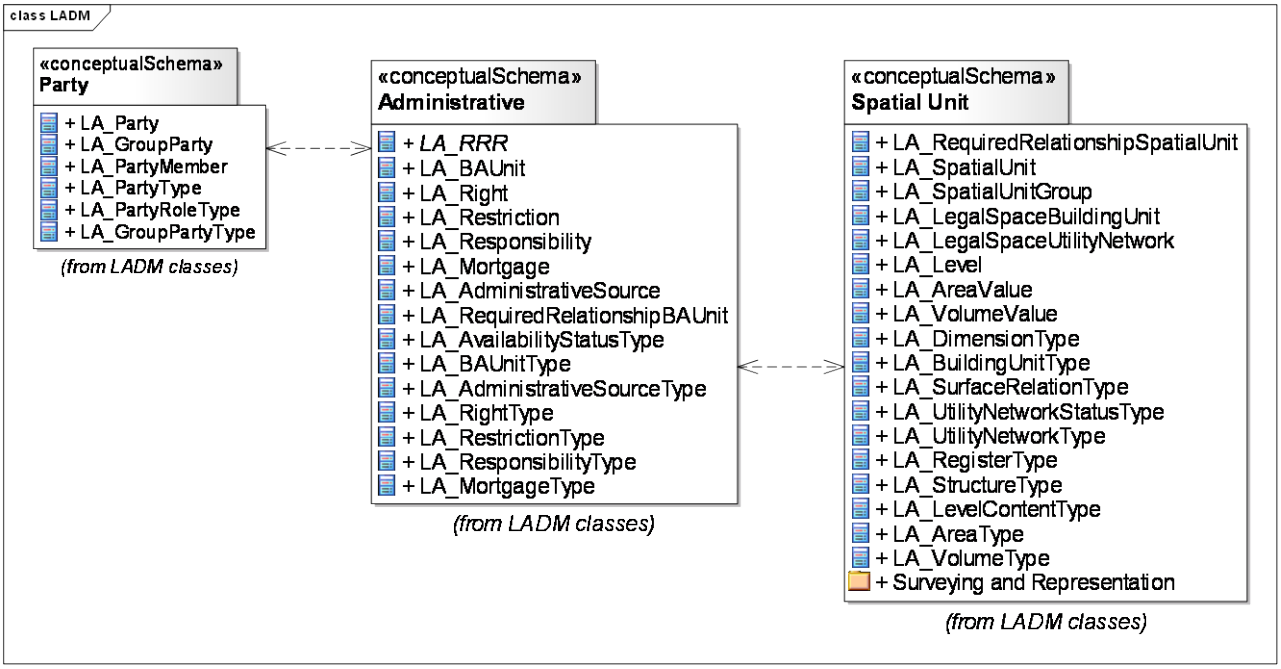

Fig. 2: Land Administration Domain Model (LADM) packages [3].

Fig. 2 is an overview of the LADM packages as discussed in the ISO 19152 [3]. The main class of the party package of LADM is class LA_Party with its' specialisation LA_GroupParty. There is an optional association class LA_PartyMember. A Party is a person or organisation that plays a role in a rights transaction. A "group party" is any number of parties, forming together a distinct entity. A "party member" is a party registered and identified as a constituent of a group party.

The administrative package deals with the abstract class LA_RRR (with its' three concrete subclasses LA_Right, LA_Restriction and LA_Responsibility), and class LA_BAUnit (Basic Administrative Unit). A "right" is an action, activity or class of actions that a system participant may perform on or using an associated resource. A "baunit" is an administrative entity consisting of zero or more spatial units (parcels) against which one or more unique and homogeneous rights (e.g. an ownership right or a land use right), responsibilities or restrictions are associated to the whole entity as included in the Land Administration System. "baunit" is a basic property unit with two spatial units (e.g. an apartment or a garage). A "baunit" may play the role of a "party" because it may hold a right of easement over another, usually neighbouring, spatial unit [3].

The spatial unit package consists of the classes LA_SpatialUnit, LA_SpatialUnitGroup, LA_Level, LA_LegalSpaceNetwork, LA_LegalSpaceBuildingUnit and LA_RequiredSpatialUnit. A 'spatial unit' can be represented as a text ("from this tree to the river"), a point (or multi-point), a line (or multi-line), representing a single area (or multiple areas) of land (or water) or more specifically, a single volume of space (or multiple volumes of space). Single areas are the general case and multiple areas the exception. Spatial units are structured in a way to support the creation and management of basic administrative units. A "spatial unit group" is a group of spatial units; e.g.: spatial units within an administrative zone or within a planning area. A "level" is a collection of spatial unit with a geometric and/or topological and/or thematic coherence [3].

The Spatial Unit package has one Surveying and Spatial Representation Subpackage with classes such as LA_SpatialSource, LA_Point, LA_BoundaryFaceString and LA_BoundaryFace. Points can be acquired in the field by classical surveys or with images. A survey is documented with spatial sources. A set of measurements with observations (distances, bearing, etc.) of points, is an attribute of LA_SpatialSource. 2D and 3D representations of spatial units use boundary face string (2D boundaries implying vertical faces from a part of the outside of a spatial unit) and boundary face string (face use in 3D boundaries of a boundary of a spatial unit) [3].

LADM related studies

Since the early versions of the LADM, studies have been conducted in some countries and/or jurisdictions to test the applicability of the model or develop country-specific profiles. Examples of such studies include the country profiles of the Portugal [7, 19], Indonesia [23, 24] Japan and Hungary [25]; Australia [3]; Korea and Cyprus [26, 27].

In Europe, LADM was applied in the Infrastructure for Spatial Information in Europe (INSPIRE) in order to "prove its compatibility" with INSPIRE cadastral parcel model [3]. Further investigations were undertaken to examine the integration of LADM with European Land Parcel Identifications Systems (LPIS) implemented in the European Union [3]. In order to support the pro-poor land management, the UN-HABITAT initiated a concept of Social Tenure Domain Model (STDM) [8]. The STDM is a subset of LADM for modelling the relationship between people and land in the pro-poor environments e.g. informal settlements, which are mostly excluded from formal land registrations systems. Elia et al [26] investigated the adoption of Core Cadastral Domain Model (CCDM) (LADM's older version) in the Cyprus Land Information System with an aim of improving its' data model. In Portugal, an object-oriented conceptual model based on LADM was developed for its cadastre and real estate register. The study found that a limited number of CCDM were not needed and other classes were needed to address the Portugal situation [19].

Kalantari et al. [30] proposes "a spatially referenced data model based on the legal property object'' within unique combinations of every interest and its' spatial extent. This model is aimed aim at replacing the traditional physical land parcel model. Any kind of interest (i.e. right, restriction or responsibility) in land is argued to have the same logical construction for spatial identification purposes meaning the RRRs are not seen as a separate entity or class. However, Lemmen [27] argue against approach stating that RRRs are defined in legislation and shared with different organisations having maintenance responsibilities of attributes of a legal property unit.

Other initiatives include the OSCAR data model and software architecture using the LADM. The objective of OSCAR is to develop a cadastral application that uses the LADM [28]. Lemmen [27] argues that although "the OSCAR data model and software architecture complement the approach the LADM, the difference is that the OSCAR approach is event-driven rather than state-based". However it maintained that the approach provide a generic view in that it historical records maintained with changes based on documents, it relevant for the LADM development from data perspective.

Earlier studies upon which the LADM is based include the Cadastre 2014 vision [11]. The Cadastre 2014 provided that the modern cadastral systems need to move way from the traditional concept of cadastre to a more integrated cadastral modelling and legal land objects. There these studies were done by ESRI to develop what is termed "ArcGIS Cadastre 2014 Data Model vision" [9].

The review of available research on the LADM presented in this section highlighted some of the various investigations into the application of the model (based on its various versions since its early stages). However, South African studies exploring the applicability of the model within its local situation are not readily available.

Land information system

In the early 1980s, Dale and McLaughlin [2] defined LIS as "a system of acquiring, processing, storing and distributing information about land". The International Federation of Surveyors (FIG) [29] uses the term "cadastre" to refer a parcel based LIS: "a cadastre is a parcel based and up-to-date land information system containing a record of interests in land (i.e. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements". The inclusion of "a geometric description of land parcels" in this definition means that the information is geographically referenced to unique units of land. It is possibly for this reason that some authors describes LIS as a subset of Geographic Information System (GIS) for land-related information such as property ownership, boundary records management; cadastral and land use mapping. Simpson [4] refers to a cadastre as "a public register of the quantity, value and ownership of the land (immovable property) in a country, compiled to serve as a basis for taxation". A register of deeds is a public register of in which documents affecting rights in land are copied or abstracted. A register of title is "an official record of rights in defined units of land as vested for the time being in some particular person or body, and of the limitations, if any, to which these rights are subject."

City of Johannesburg (CoJ) Land Information System

CoJs need for a seamless integration of the property information within its jurisdiction has started over a number of years. This followed a realisation that the data in CoJ was duplicated across various departments making the executing of business processes that relied on accurate and timely property information challenging. Historically, property data was distributed and duplicated throughout CoJ in various systems that were incompatible with each other, leading to data discrepancy and duplication. In order to solve this challenge, CoJ had reviewed its' operational processes with an aim of redefining its' various value chains that were implemented. Property Value Chain (PVC) was one of the value chains which required revision so as to streamline it to provide a better service to its'-customers. The Value Chain Model method is a useful "process-oriented" model for systematic visualization of an organisation's operations relative to its information needs [14]. The aim of this model is to delineate various components of an organisation's operations based on common goal of value creation. Property is a key revenue driver within any municipality. The PVC is recognised as a key revenue driver for CoJ as indicated in Fig. 3. It is triggered by any transaction that affects the ownership, status, attributes and value of registered property in the City of Johannesburg. The ability to secure revenue (assessment rates, service billing) is dependent on accurate and timely identification and valuation of properties and the accurate and prompt transfer of that property related information essential for the billing purposes.

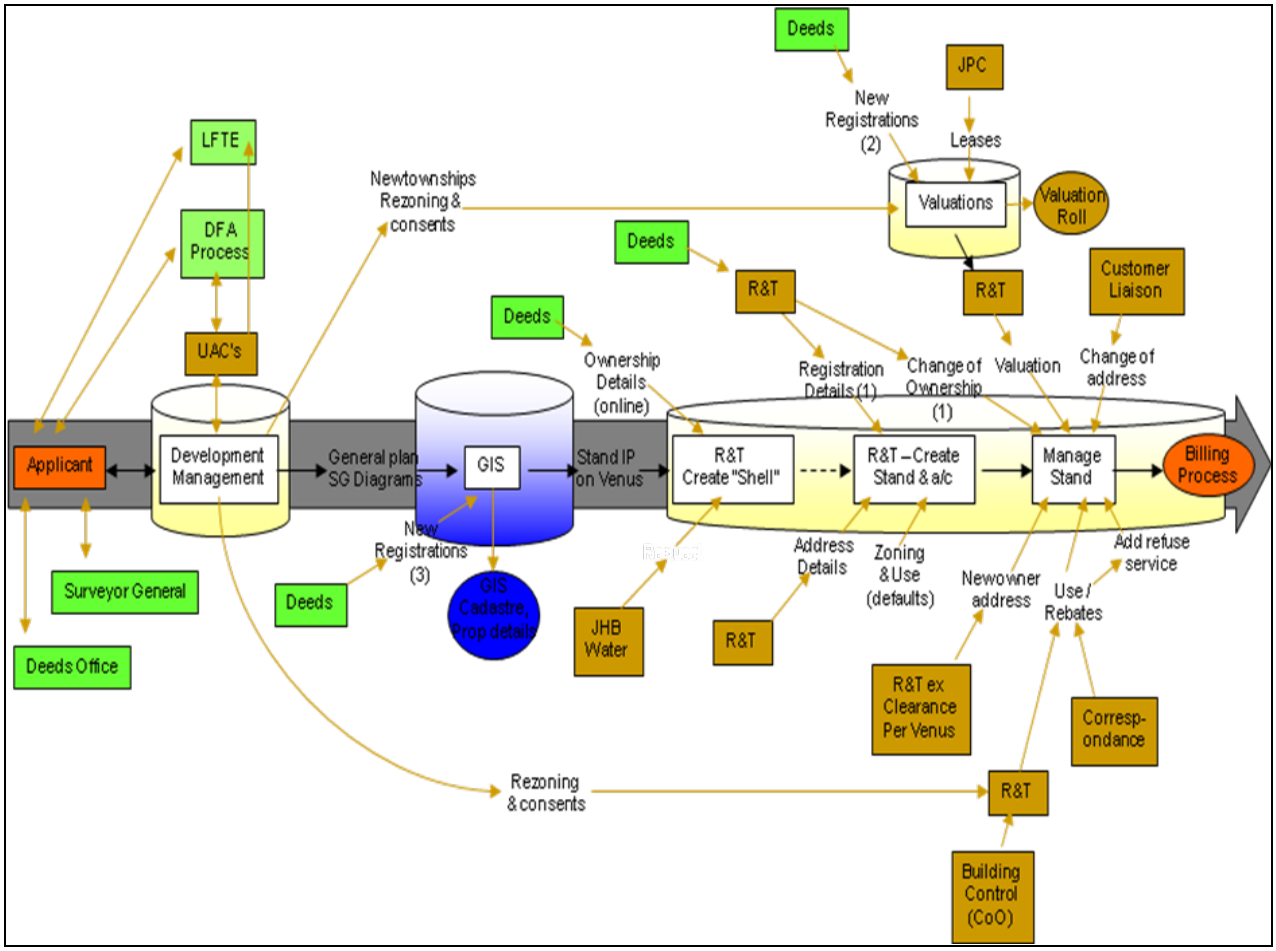

Fig. 3: Property value chain (City of Johannesburg, 2011).

The LIS project was implemented as key component of the PVC of CoJ. The early phases of LIS were implemented in 2007 and 2008. The ultimate goal of the LIS is to become a one stop-shop for all property related information providing necessary property information to the SAP system for billing purposes and other fiscal matters. The PVC/LIS is a complex model consisting of all stakeholders, as illustrated in Fig. 3, which are directly involved in the processes of:

- Facilitating creation and management of changes in properties approved in the surveyor-general offices and the rights of which are registered in the deeds office;
- The maintenance of these information (registered properties);
- Determining and maintaining the municipal value of properties and those dealing with accurate and prompt transfer of information to the billing processes.

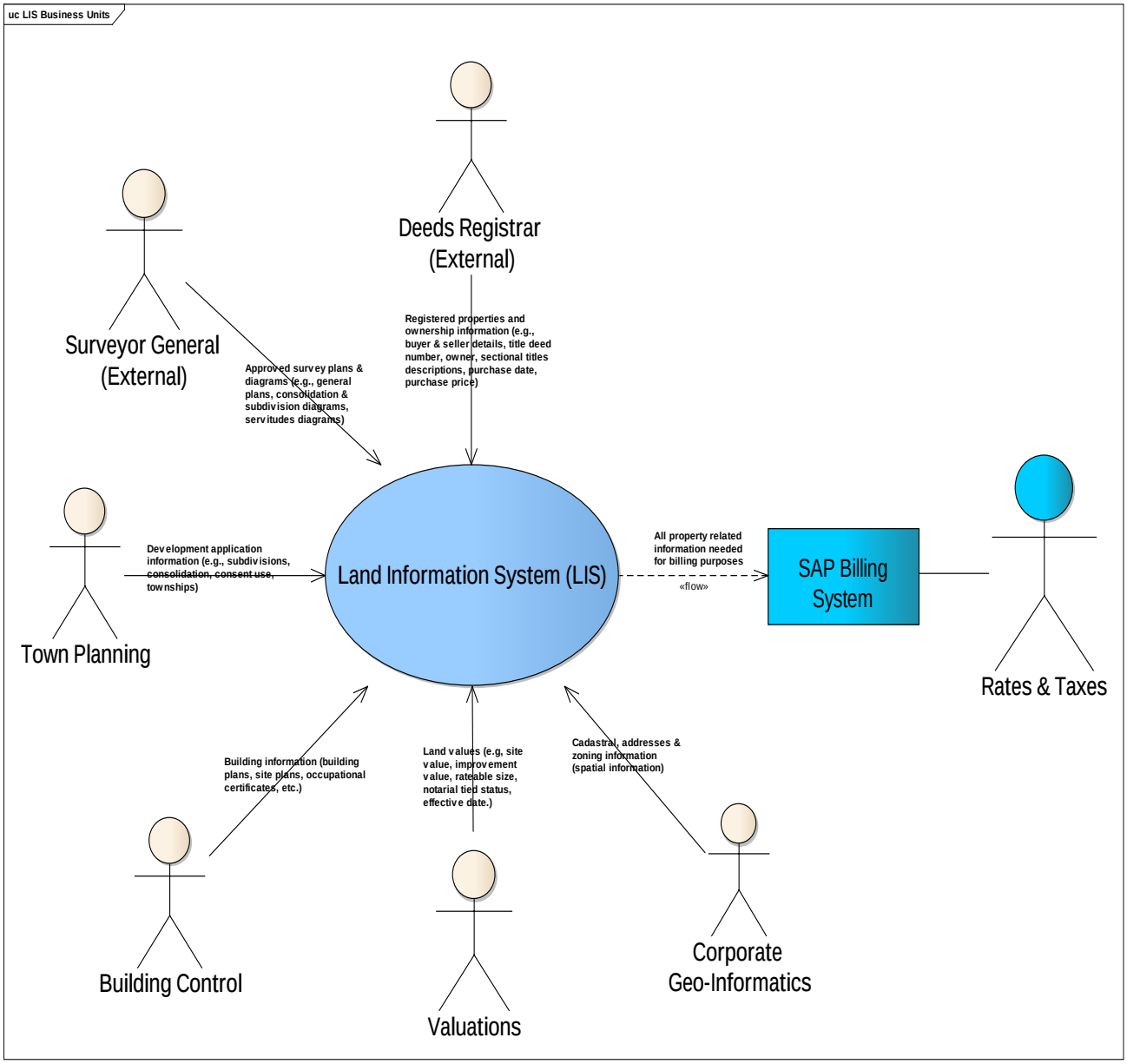

Fig. 4: Parties involved in the CoJ LIS as a component of PVC.

The LIS as illustrated in the Fig. 4 above, the Corporate Geo-Informatics (CGIS), Valuation Department, Building Control, Town Planning Directorate and Rates and Taxes (Revenue Management Department). It also includes the office of Deeds Registrar and Survey-General offices. The each party play different role and responsibility within the LIS. For example the office of the deeds supplies the registered property information via weekly deeds file. This information is needed to maintain the change of ownership in the LIS. The Surveyor-General provides electronic images of the approved survey plans and diagram of property which are they captured into the GIS by CGIS. The planning department is responsible for feeding GIS with development applications information. While Rates and Taxes maintain customer accounts, statements in a SAP billing system. There are different systems managing this process this include Town Application System (TAS); Building Application System (BAS), Geographic Information System (GIS); Valuation System (VS). The integration of these systems into a proper workflow application is crucial. This is said to be one of the key issues that the LIS Upgrade Project will address which is to be implemented.

In this paper examine the current core data model of the LIS with an attempt to re-design it to comply with the LADM specifications. The LADM is said to offer benefits such as interoperability, improved data management and quality control in one organisation or organisations which have various responsibilities in the maintenance of land associated with parties, rights, restrictions and responsibilities and their geospatial/geometric components. LIS deals with such type of information.

The migration COJ LIS core entities to LADM classes

In this section the enhancement of the data model of the LIS, with the adoption of the LADM is examined. In the COJ LIS, all data related to properties, ownership and owners, attachments and valuation data are stored in the property database. The property database is a mirror of the contents of the Deeds Registries data and contains all the necessary information about parties registered sellers and buyers, theirs real rights with associated restrictions. The LIS core property data model is illustrated in Fig. 5.

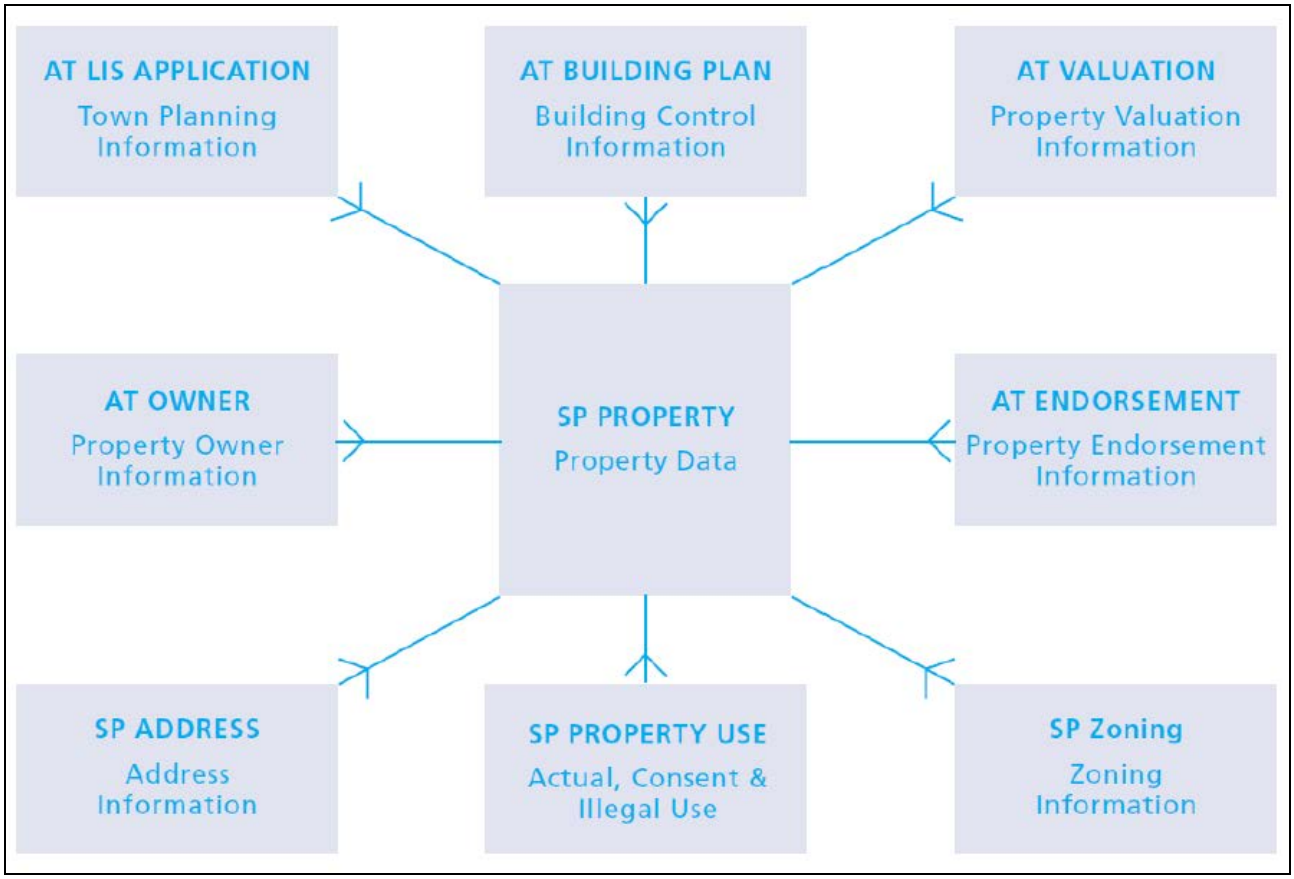

Fig. 5: Core property data model of LIS (City of Johannesburg, 2011).

Methods

One of the top academic journals in information systems (IS) research has shown that survey method is predominately used for conducting research in IS following the case study method, laboratory experiments and field analysis respectively [15]. Literature analysis, speculation and commentary, mathematical model and secondary data are ranked middle. Although the outcome of IS analysis, shows this particular trends in methodologies applied of IS research, it advocates that an optimum balance be encouraged for diversity in research. The case study is a study of a single phenomenon (information system, application, decision) in an organisation over a logical time frame respectively [15]. The rationale for the case study method choice for this research was based on four conditions for selecting case study as an appropriate method for conducting research [16]:

- Phenomenon is complicated
- The body of knowledge that is currently available presents challenges when causal questions are asked
- Where are where an all-inclusive and detailed study is necessary
- Separate from its' context, the phenomenon cannot be examined

A phenomenon under empirically investigation in this paper is the LIS implemented in CoJ. The CoJ LIS is a complex system involving a number of parties which interact with it at various phases in the PVC process. It cannot fully be understood by posing causal questions. An in-depth and empirical investigation is necessary in order to identify classes, attributes and external classes LADM that can be applied to LIS in order to make it compliant with it. Therefore, this paper explores how the LADM can be applied to South African perspective using the CoJ LIS as a case study. The CoJ LIS was chosen for practical reasons as the author has direct experience and interaction with the LIS on daily basis

since its' first implementation phases in 2007. The study uses a content analysis approach to systematically examine the information content the CoJ property value chain model (i.e. LIS data model) in order to identify RRRs and geospatial and/or geometric components are modelled.

In order to comply with the LADM, the LIS core entities need to be migrated into LIS entities to LADM classes. The following section deals with the migration of the LIS core model into the LADM. A detailed examination of these entities/classes indicated that there is a direct relation between them, and the proposed LIS/LADM migration is shown in Fig. 6.

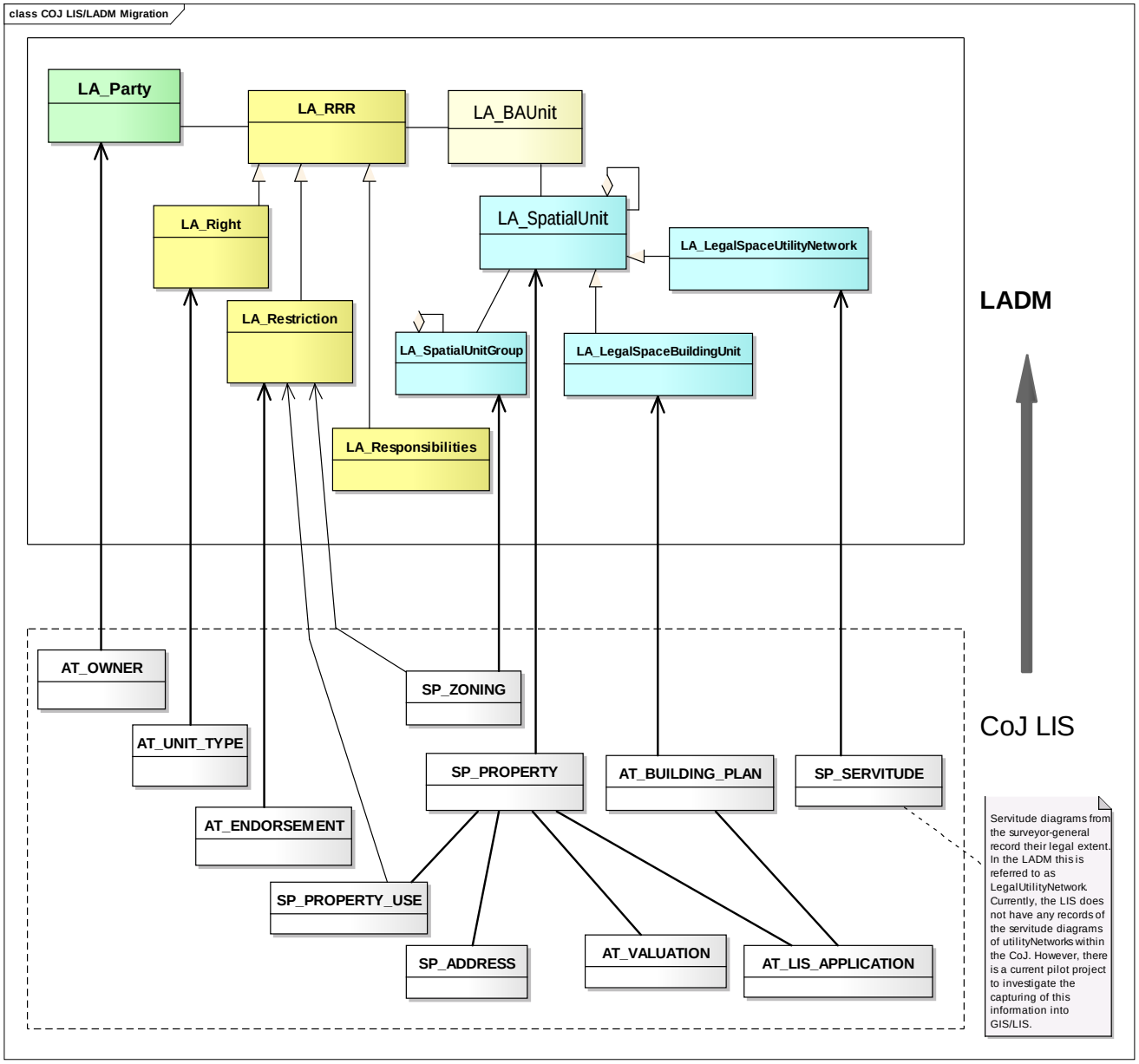

Fig. 6: The proposed LIS/LADM entities migration.

AT_OWNER can be incorporated in the LA_Party

AT OWNER contains information on the legal owners of property. This information is obtained from the Deeds Office. The multiple property fields indicate whether the person owns more than one property. The multiple owners field indicate whether the property is owner by more than one owner. The LIS party classes were created from the deeds weekly file as indicated in Fig. 7. This information assisted identification of person types in the LIS. The LIS contained on the codes (such as personType = 1). The parties illustrated in Fig. 7 are registerable in the Deeds Office. Ownership is recorded as fractions, if more than one owner is recorded for a property. The sum of the fractions for each property should be the equivalent of 1/1 at any point in time.

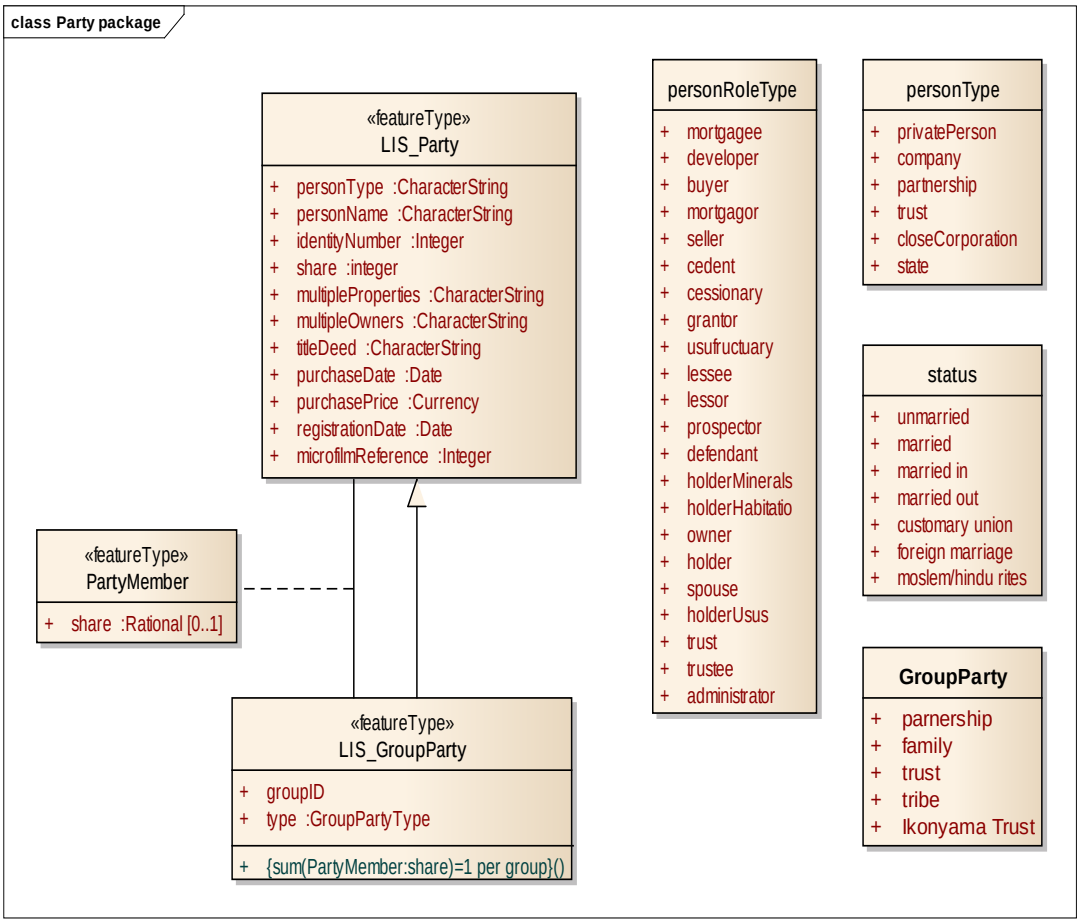

Fig. 7: LADM and LIS party based on municipal weekly deeds files.

AT_ENDORSEMENT; SP_PROPERTY_USE and AT_UNIT_TYPE can be incorporated in the LA_RRR

Rights (R)

In the LIS the AT_UNIT table (which is not presented in the diagram as core LIS entity) contains the nature of rights under field name UNIT_TYPE: These rights include servitudes, sectional title, long term leases, surface right permits, reversionary interest etc.

Restrictions (R):

AT ENDORSEMENT stores information about all endorsements and bonds (e.g. mortgage bond) registered against the property. Endorsements can be notorarial ties, mineral rights, sequestrations, servitudes. Or anything else related to the property.

This is applicable for rezoning applications if the registered owner has a mortgage bond on the property. The bond holder is the institution that financed the property. It has to provide a letter stating that it has no objections to the application for land use changes. The public rights are recorded in the SP_PROPERTY USE and SP_ZONING need to be migrated into Restriction class of LADM. SP ZONING contains information related to zoning type, zoning schemes, consent use, permissible use. SP PROPERTY USE contains all information related to the actual, consent and illegal use of properties. These tables may be migrated into the LA_RRRs. Restrictive title deeds conditions are registered in the Deeds office (Fig. 8).

Responsibility (R)

Responsibilities are recorded in the title deeds conditions and in the condition of township establishments. An owner may be obliged to fence his/her property or maintain the grass or to use specific building material when erecting a physical structure.

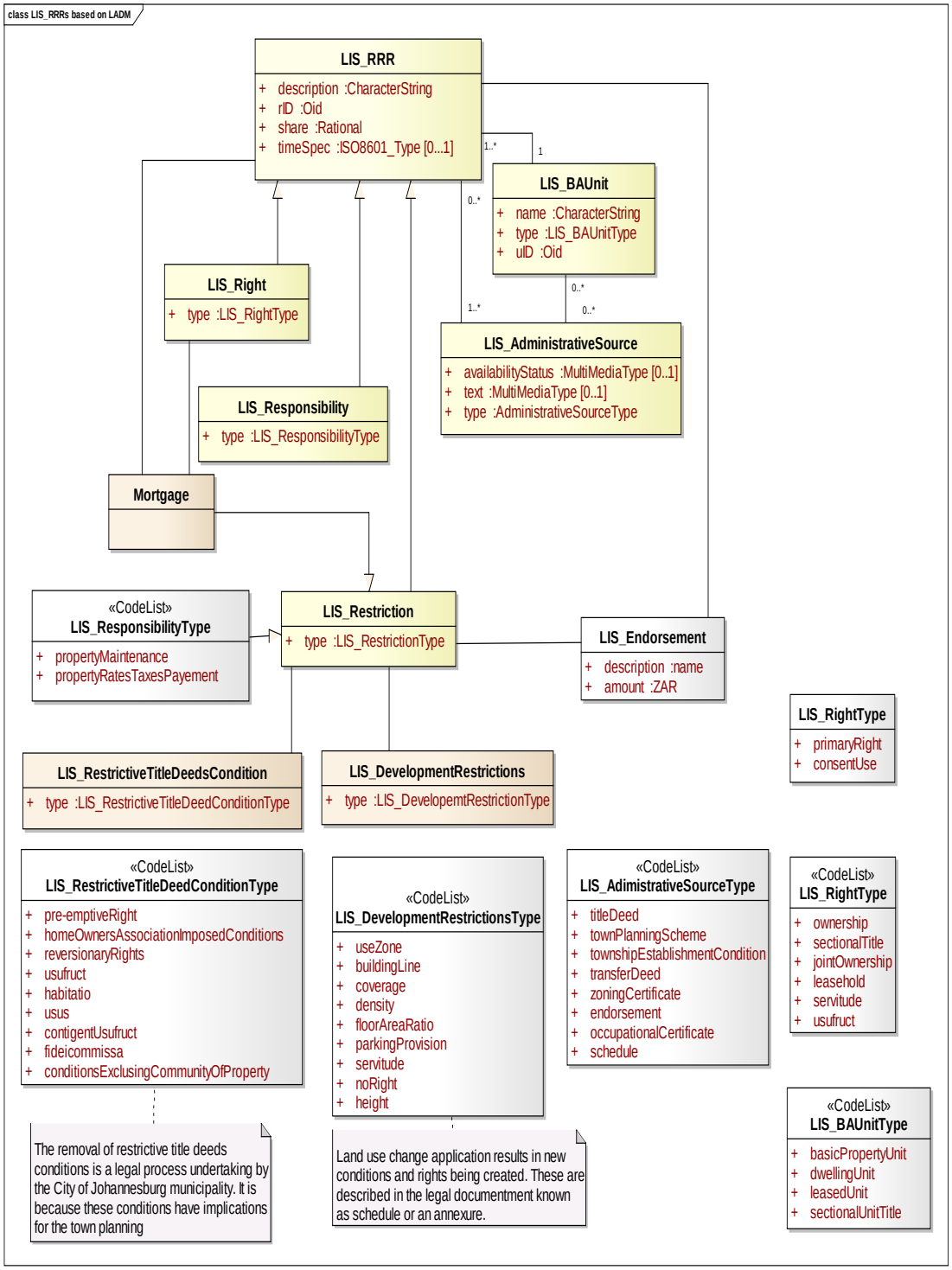

Fig. 8: Profile of Administrative RRRs.

SP_PROPERTY can be incorporated into LIS_SpatialUnit

The SP_Property is the central entity in the LIS, as it contains an identification of all immovable properties within CoJ as illustrated in Fig. 5. The property identification is used to record the ownership or lease of a property and can also be used as a recording of persons liable to pay property tax. The “property” entity does not hold much information in itself, but can be considered as an umbrella for a more detailed description of the property. The information that must be is recorded for a registered property can be summarised as: ownership, at least one subproperty, e.g. parcel or unit, the parcel on which the property is located. The LIS supports only 2D representations. There is, however, an increasing interest on 3D representations of building footprints.

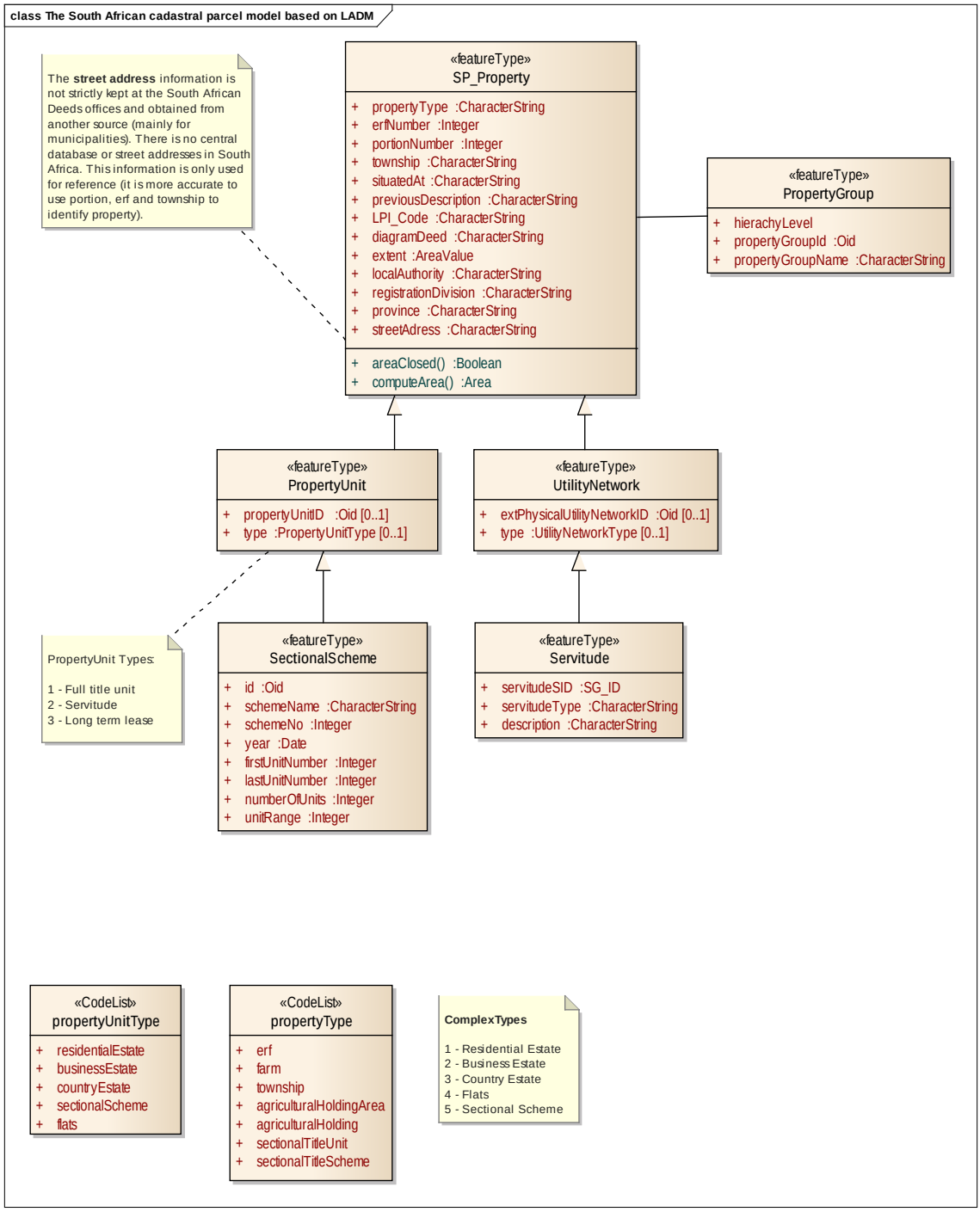

Fig. 9: LIS SP_Property based on LADM.

The LIS property data model was examined to identify the classes, attributes and other variables. The model attributes were examined and compared to the official registerable property descriptions from the Deeds information and from the SG plans and diagram. The purpose of this comparative analysis is to bring a common legal description of spatial units.

The AT_BUILDING PLAN can be incorporated in the LA_LegalSpaceBuildingUnit

The AT BUILDING PLAN class contains information related to building control (building line, site plans, elevations, occupational certificates and other certificates. The National Building Regulations and Building Standards Act (Act 103 of 1977 as amended) [22] which is the legislation that governs the process of accepting, assessing and approving building plans applications by Local Authorities. LA_LegalSpaceBuildingUnit can be used for the building registration. LADM provides registration legal space for buildings in 3D as legal space does not necessarily coincide with the physical space of a building. This information is important for building control purposes. For example, a building line is a line that demarcates an area where building is restricted such as the construction of buildings not being allowed in a

certain zone or the type of building that is allowed is limited (e.g., on stands zoned Residential 1 in the Johannesburg Town Planning Scheme, garages, carports and outbuildings may be constructed within this area, but not a dwelling.

In the LIS the UtilityNetwork information relates to categories valuation. The LIS does not currently record utilitynetwork information in the SP_PROPERTY. However there is an on-going pilot project to investigate the possibility of capturing servitudes diagrams into GIS data to represent the legal space of this information. The paper proposes the inclusion of servitudes and other utilitynetwork infrastructure legal space under the LA_LegalSpaceUtilityNetwork as subclass from LA_SpatialUnit. The registration of access to utilities as restrictions to other land rights of other parties (rights of way, encumbrances and servitudes) is important. It is important to recognise that legal space around a utility pipeline does not necessarily coincide with the physical space of a pipeline in a network.

SP_ZONING; PROPERTY_USE can be incorporated in the LA_SpatialUnitGroup which allows for definition of level in the hierarchy of administrative subdivisions for town planning zone (residential, commercial, business etc.). CoJ has seven administrative regions, voting districts and wards and a number of town planning scheme areas. Land use is an interest in land and can be incorporated in RRRs data elements. Interests are now more diverse that those traditionally recorded in deeds registries. Land use restrictions are recorded by planning department separate from real rights (ownership, long leasehold, sectional title etc.)

SP_ADDRESS

In the LADM, Address concerns spatial unit addresses. Address registration (including postal codes) standards for addresses are under development as in ISO 19160 (ISO/TC211, 2011). However parties can also have addresses but in the LADM those addresses are considered to be available via extParty class. Street address information is maintained by municipality for the purposes such as valuation and property billing. The external class of ADDRESS is required.

AT_LIS APPLICATION contains all information related to town planning: application type namely; consent, rezoning, new townships, building plan queries, advertising (boards and regulations); and requests for appointments

AT_VALUATION contains records of valuation provided by the CoJ and represent the market value assessed for rates and at the date of valuation.

Discussion

The LIS is based on the South African conventional cadastral model. The Chief Surveyor-General is responsible for examining and approving all cadastral surveying, compiling and maintaining of plans and diagrams showing relationships of various parcels of land to each other. The Land Survey Act [21] makes provision that all diagrams of land or general plans are prepared by a qualified land surveyor and examined and approved by the Surveyor-General (SG) before registration according to the Deeds Registries Act [7]. The Act further provides that every approved diagram or general plan be allocated its own identifiable diagram number or plan number. This is essential information for the GIS to identify and capture new approved properties (general plans for new townships, subdivisions, consolidation diagrams). The images of SG plans and diagrams are also kept in electronic medium. This information was accessed and analysed to identify classes, attributes and variables for the LADM profile for the City of Johannesburg. These conditions may restrict the use of the land and also oblige the property owner to undertake certain actions on his/her property within a specific time. For example, the height of a building on a subdivided portion of land may be restricted; or an owner may be obliged to fence his/her property or maintain the grass or use specific building material when erecting a physical structure.

The adaptation of the LADM model within the LIS can bring about complete record of private and public rights more appropriately and in an integrated manner. The LADM codeList offers ways of achieving this. The inclusion of informal rights (informal rights, land reform) with LADM is critical for proper planning. The organisation or party and their role in the LIS above those described by deeds (seller and buyer) in the LIS would enable proper accountability of parties involved in the LIS. LADM organises information related to parties, RRRs and their geospatial and/or geometric components in such a way that clear responsibilities for maintenance of specific data be achieved. Each party in the LIS plays different roles which can be improved through the introduction of a common language (vocabulary). From the system design, development implementation perspective, the LADM offers the benefits for the current LIS Upgrade Project to develop an integrated workflow application (or software) based on the ISO standard. LIS involves external government agencies such as the Deeds and Surveyor-General offices. The development of a profile of LADM can improve that interoperability and allow for easy sharing of information that is based on common data model. In so doing the current data quality problems which occur during the data processing between systems can be resolved. The development of common standard model based on LADM provides the Deeds and Surveyor-General office with an

opportunity to implement international standards in its current e-Cadastre project. There is a need for further investigation to develop systems and applications based on LADM in South Africa, particularly those addressing the current land reform challenges such as insecurity of land tenure in pro-poor environments. The LADM is important for achieving the objectives of SDI in South Africa in that it promotes the standardisation of land information and services in one or more organisations.

Conclusion

In this study, we explored the applicability of the LADM model with the City of Johannesburg. The LIS core entities were examined. The model is applicable to City of Johannesburg. It provides an opportunity for the development of LADM based model for the integrated LIS workflow application which is part of the current LIS Upgrade Project. This paper started with the description of LA, LADM, the CoJ LIS and the parties involved in the LIS. The data provided by the parties were analysed in order to identify classes and attributes of LADM that are applicable to LIS. The classes and attributes were modelled in using UML using packages of LADM as framework to group the information. It is evident from the diagrams of LIS that the LADM is applicable for the CoJ. There is a need for further research to validate the applicability of LADM in other municipalities.

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