

Analysis of the Application of the LADM in the Brazilian Urban Cadastre: a Case Study for the City of Arapiraca, Brazil

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Key words: LADM, Urban Cadastre, Brazilian Cadastre

SUMMARY

This research explores the potentialities of the Land Administration Domain Model - LADM and its application in the Brazilian Urban Cadastre. The implementation of the model suggested by the ISO 19152 was tested using the cadastral database of the municipality of Arapiraca as a case study for the codification of parcels in 2D. The physical model was elaborated according to the normative proposal, and the analysis of the results showed the compatibility of the LADM with the concepts proposed by the guidelines established by the Ministry of Cities (Ministerio das Cidades) in 2009, for the implementation of multipurpose cadastres in Brazilian municipalities.

RESUMO

Esta pesquisa explora as potencialidades do LADM e sua aplicação no cadastro urbano brasileiro. A implementação do modelo sugerido pela ISO 19152 foi testada utilizando como estudo de caso o banco de dados cadastrais do município de Arapiraca para a codificação de parcelas espaciais em 2D. O modelo físico foi elaborado de acordo com a proposta da normativa, e a análise dos resultados indicou a compatibilidade do LADM com os conceitos propostos pelas diretrizes estabelecidas pelo Ministério das Cidades em 2009, para a implementação de cadastros multifinalitários nos municípios brasileiros.

Palavras-chave: LADM, cadastro urbano, cadastro brasileiro

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1. INTRODUCTION

In Brazil, the Land Administration System is characterized by the land registry, responsible for legal information, and the cadastres. The rural cadastre is federal, while the municipalities structure and administer the cadastres of urban areas, generally with tributary finalities.

The municipalities determine the contents of the cadastre and carry out the cadastral surveys without any standardization. This occurs because there is no specific legislation which deals with registration norms, although most still use a model that was disseminated in the country in the 1980's through a national modernization project of the municipal administration.

In 2009, the *Portaria n.511* (Brasil,2009) of the Ministry of Cities (*Ministério das Cidades*) was published, establishing guidelines for the creation, institution and update of the Multipurpose Cadastre (MC) in Brazilian municipalities. This normative establishes the importance of the MC and defines the Multipurpose Cadastre as the official and systematic land inventory of the municipality, based on the surveys of the limits of each parcel, which receives an unequivocal numeric identification. This is, therefore, the first document of national coverage which proposes a standardization of concepts for the implementation of the cadastres in urban areas.

The *Portaria 511/2009* deals with questions such as land unity to be registered, cadastral mapping, multipurpose use of the cadastre, management and financing of the cadastre, and land evaluation – and includes the legal framework in which these guidelines are supported. Therefore, it is a guiding document, not a law which would be obligatory in nature.

In the context of the normatization of the cadastre through ISO 19.152 (ISO,2012), which proposes standards for modeling and the sharing of land information, as well as making available information about the institution of the *Portaria 511/2009*, this study explores the potentialities of the Land Administration Domain Model (LADM) and its application on the Brazilian urban cadastre – analyzing its conformity with the concepts proposed by the *Portaria 511*. The implementation of the model suggested by ISO 19152 was carried out by using the cadastral database of the municipality of Arapiraca, state of Alagoas, for the codification of the parcels in 2D.

2. THE BRAZILIAN LAND CADASTRE

Because of lack of legislation which establishes general guidelines for the operation of the cadastre in Brazil, as well as technical norms for its implantation and maintenance, it is the responsibility of each city hall to manage the urban cadastres, which are established primordially for tax purposes (although a tendency for multipurpose use has risen in recent years). The rural cadastre is of federal responsibility, administered by the INCRA – *Instituto Nacional de Colonização e Reforma Agrária* (National Institute of Agrarian Colonization and Reform).

The description of the parcel in the registry does not depend on the description in the cadastre (since this cadastre may not even exist). By the law of public registrations (law 6.015/73), "the identification of the parcel is carried out through indicating its characteristics, location and denomination, if rural; and by number if urban." Law 10.267, of August 2001, establishes the georeferencing of rural parcels. The description of these parcels is done through the coordinates of its boundaries referred to the Brazilian Geodetic System.

Law 10.267/01 (Brasil,2001) promised the ending of illegal appropriation of public lands. The new legislation was created as a consequence of a demand that had long been repressed. There was social pressure for legal instruments to facilitate land processes, as well as for the regulations that followed. Aside from georeferencing of rural parcels, the law deals with other very important points: the exchange for information with the land registry, essential in environmental and regularization actions, and the creation of the National Cadastre of Rural Properties (*Cadastro Nacional de Imóveis Rurais – CNIR*), a singular cadastre of information about rural parcels in the country, which includes sharing of information with other cadastres: environmental, indigenous lands and public federal lands – each with its own base of descriptive and graphic information. Until the present moment, the CNIR has not been effectively implemented.

An analysis of the Brazilian cadastre points out some characteristics which demand coordinated action for the reform and standardization of the system. Among these characteristics, the following are of utmost importance:

- the responsibility for the cadastre in Brazil is fragmented according to the location of the cadastral unit: there is the rural cadastre, which is of federal administration and legislation; and the urban cadastre, which is the responsibility of the city halls of the municipalities and has no specific standardization nor legislation;
- it is possible to identify, in both types of cadastres, an unacceptable duplication of efforts and of spending. And it is easy to find duplication of information within the city halls themselves, where different sectors produce the same information;
- the lack of integration with land registries makes the cadastres unreliable in terms of legal information, which results in incalculable economic and social losses, such as unending expropriation processes and inefficient tax charges, due to wrong information about the holder of the rights over the property;
- with respect to taxation, an updated and complete cadastre can facilitate the desired tax equity by obtaining more precise values from the calculation base of the land tax – the market value of the property

Establishing standards for modeling a land administration system is a challenge for a country such as Brazil. Its continental dimensions and great cultural diversity bring to the Brazilian cadastre very specific particularities varying from region to region and even among municipalities. The ISO 19.152 – LADM, proposes a model for cadastres and registrations

which facilitates the sharing and comprehension of each system, as well as the relation among the parts – thus the aim of this study was to evaluate its application on urban cadastres.

Other research studies in progress deal with the LADM applied to the cadastre of public lands and, more specifically, to the cadastre of indigenous lands. It is also important to evaluate its application on the cadastre of rural lands, considering current legislation for this type of cadastre.

2.1 Multipurpose Cadastre of Arapiraca

Research studies carried out by Carneiro (2001) and Farias (2012) indicate that, despite the lack of standardization and of heterogeneity in Brazilian urban cadastres, the principal element of a cadastre is always present: the identification of the relationship person/land. Although many different situations are found with respect to the use (or not) of geotechnologies, the environment (analogical/digital) and the content of the cadastral information base, there are some similarities among the different cadastres, the most common of which is the collection of descriptive data.

Municipalities with a relatively organized cadastre – some with characteristics of multipurpose cadastres – adopt very similar systems, facilitating studies seeking standardization. On the other hand, municipalities with very deficient systems have sought orientation and invested in capacity building for its technicians, to structure new more efficient systems. Considering these assumptions, this investigation used the case study methodology to analyze the viability of applying the LADM in Brazilian municipalities, as an important measure for perfecting their cadastres.

The case study was carried out in the municipality of Arapiraca (Figure 1), the second biggest city in the state of Alagoas, northeast region of the country. According to the Census of 2010, the municipality has a population of 214,006 inhabitants. It is one of the main cities in the region, an obligatory passage point for commercial products, on route of great economic centers. Its privileged geographical location interconnects the other geoeconomic regions of the State and it is characterized as an agricultural, commercial, industrial and service hub.

Arapiraca was chosen for this study because it is applying concepts proposed by the *Portaria 511* to its urban cadastre, which are compatible with the LADM proposal. Thus, the hope is that the analysis carried out in this municipality will help other municipalities in phase of restructuring according to this *Portaria*.

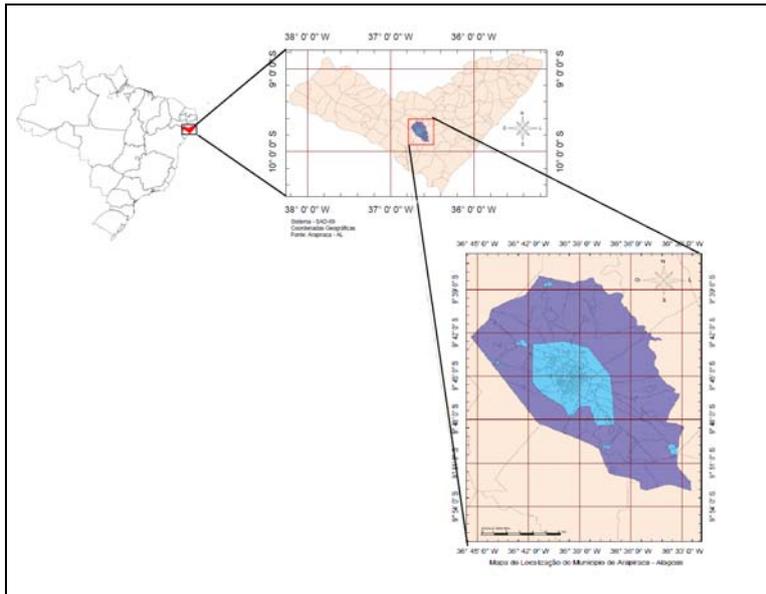


Figure 1. Location of the area of study – Arapiraca, Alagoas, Brazil.

The cadastre of Arapiraca was implemented in 1984, as an initiative of the Federal Government to encourage municipalities to increase tax collection. However, only in 2006 was a photogrammetric survey carried out to produce cadastral maps in 1:2.000 scale.

In spite of this work which updated the cartography of the city, the descriptive database was inconsistent, so it also needed updating. Thus, in 2010 a process of updating the cadastral database was initiated with the objective of raising pertinent information for the fiscal cadastre, to be used for various purposes. Some months prior to the beginning of these activities, the Federal Government published the Portaria 511/09, and the municipality decided to use these guidelines as the base for their work. Because of this, Arapiraca became one of the first Brazilian municipalities to validate the applicability of the proposal of the Ministry of Cities (*Ministerio das Cidades*).

The objective of the study was to register the 40,000 units that already existed in the database of the municipality, while estimating also the inclusion of 25,000 new units. Currently, approximately 93,000 units compose the cadastral database – including the main rural communities of the municipality – to help better manage the public services offered in these locations.

The data collection forms were updated, with the addition of essential complementary information for the multipurpose use of the cadastre. Also, a new codification system was established for the units to be registered.

The cadastral data collection process was also modernized by using portable computers, so that the data and the sketch of the parcels were collected directly and transferred to the database of the municipality.

Curretly, this cadastral database is used to integrate data from other secretariats of the municipality They incorporate their data onto the system and make it available through the internet (Portal GeoArapiraca).

3. APPLICATION OF THE LADM IN THE CADASTRE OF ARAPIRACA

One of the objectives of the LADM is to share information. Thus the system is made up of information regarding the physical characteristics of the parcels, the identification of the people who have some relation with these parcels, and the rights, restrictions and responsibilities (RRR) related to them. In this study, the principal classes LA Party, LA_RRR and LA_SpatialUnit were modeled, such that the municipalities which don't have cadastral systems implemented can use the LADM model as a basic standard for the insertion of data (Santos, 2012).

The modeling was carried out by using the MySQL as a database management system, because it has a simple open code structure. The objective of the conceptual model of the LADM, brings in its computational structure the classes and its distributed attributes as a class diagram, presenting also the different forms of relationships among the objects. To facilitate the understanding of the classes, the MySQL Workbeach application was used to model the diagrams and to carry out its conversion into a database.

3.1 LA_Party

In the LADM, the information regarding the owner or holder of the parcel is stored in the LA_Party table. Each person is related to a registry of a group of people (LA_Group), where the relational table between those classes is table LA_Member, which is responsible for sharing information among them.

For each class, an analysis of attributes was carried out to identify those which are compatible with the data of the cadastre of Arapiraca. Thus, the class of LA_Party carry information such as: the name of the person who is responsible for inserting data in the model; the name of the person related to the parcel; the name of the group of people to whom the parcel is related (in case of joint property); and the individualization of the people who are part of the group of people, through the LA_Member table. Figure 2 presents the modeling of the LA_Party and its relation with the rest of the tables which form the class.

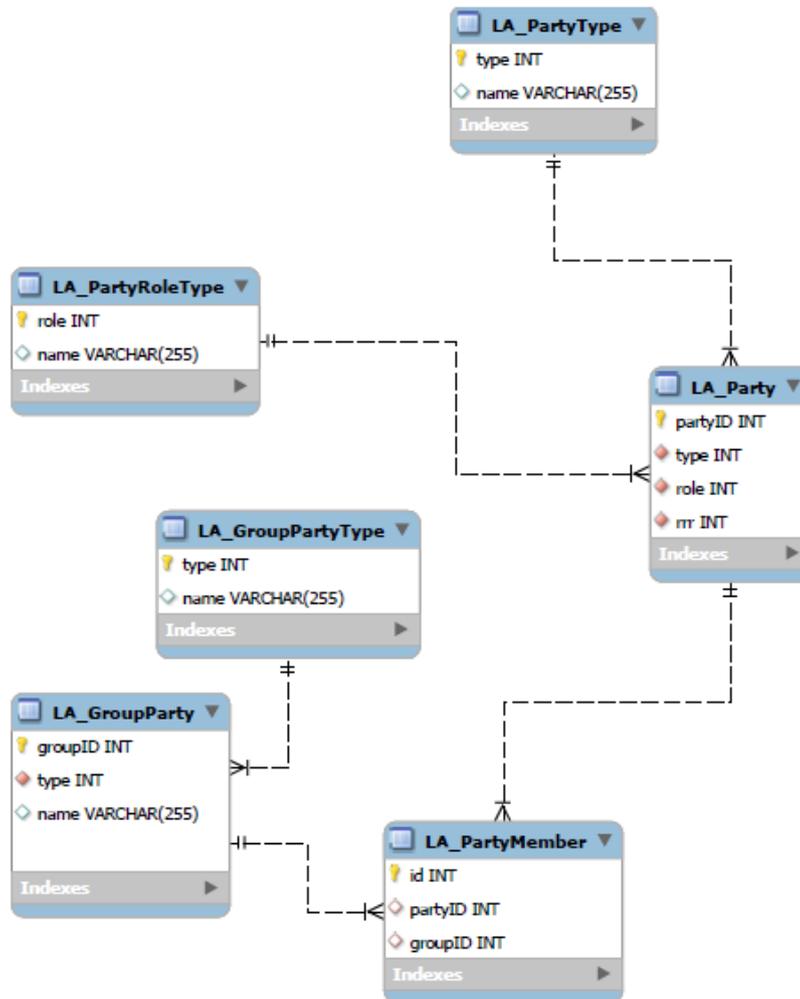


Figure 2. LA_Party

3.2 LA_SpatialUnit

The LA_SpatialUnit characterizes the parcel physically, with information about its structure and spatial representation: address, administrative unit, reference system. Figure 3 shows the parcel as a spatial unit of the LADM, and its relations and attributes in each class.

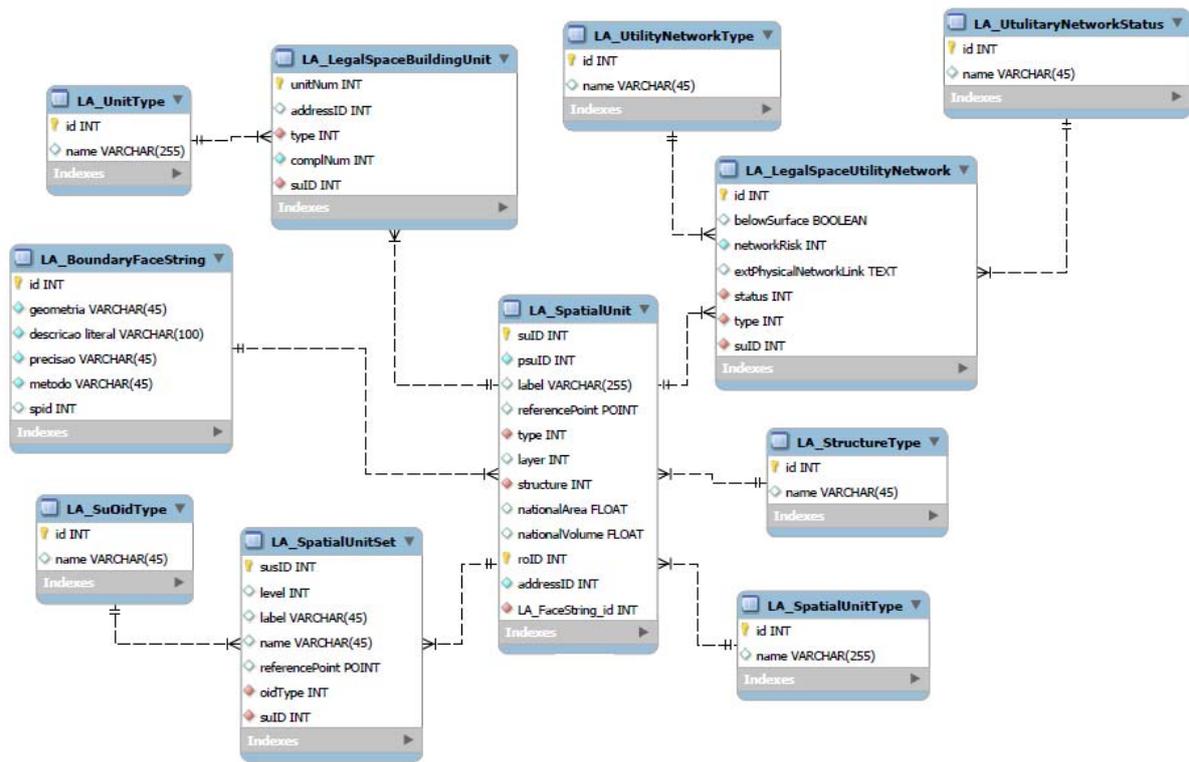


Figure 3. LA_SpatialUnit

The LA_SpatialUnit includes classes LA_Face and LA_FaceString, which are the responsible classes for the topological representation of the parcel, with the structures in 3D (LA_Face) and in 2D (LA_FaceString). In this study, only class LA_Face was validated, since the database of Arapiraca does not have registration of parcels in 3D. Figure 4 presents the relation of the spacial representation classes of the LADM model and its attributes.

3.3 LA_RRR

For the cadastre, the identification of the relation between the person and the land should not restrict itself merely to formal relations of property, and this is well defined in the LADM, which considers the inclusion of informal situations of possession. All parcels must be registered, and the LADM admits the right of property as well as of possession. The database of the city hall of Arapiraca also admits these two situations: the owner is the one who holds a registered title. Others may have possession over the parcel.

With regards to the restrictions over the right of property, there are several situations in the Brazilian legislation: urban, environmental, of use restriction in protected areas, of infrastructure networks, or of historical heritage. And these restrictions are not always informed in the registration of the parcels, which makes difficult its inclusion in the cadastre.

Another important aspect related to rights and restrictions in the LADM is the mortgage. In recent years, the government incentives to acquire properties increased the quantity of

financed properties in Brazil. In the cadastre of Arapiraca, these financed parcels are characterized as mortgaged, to identify the situation which cannot be used as guarantee for other financing. Currently, there is no other mortgage data in the cadastre of the municipality, because this formalization is done directly between land registries and financing institutions, without demanding integration of these databases with the cadastre.

The validation of the LA_RRR model was carried out with the mortgage package, according to the available information in the database used. The modeling is presented in Figure 4.

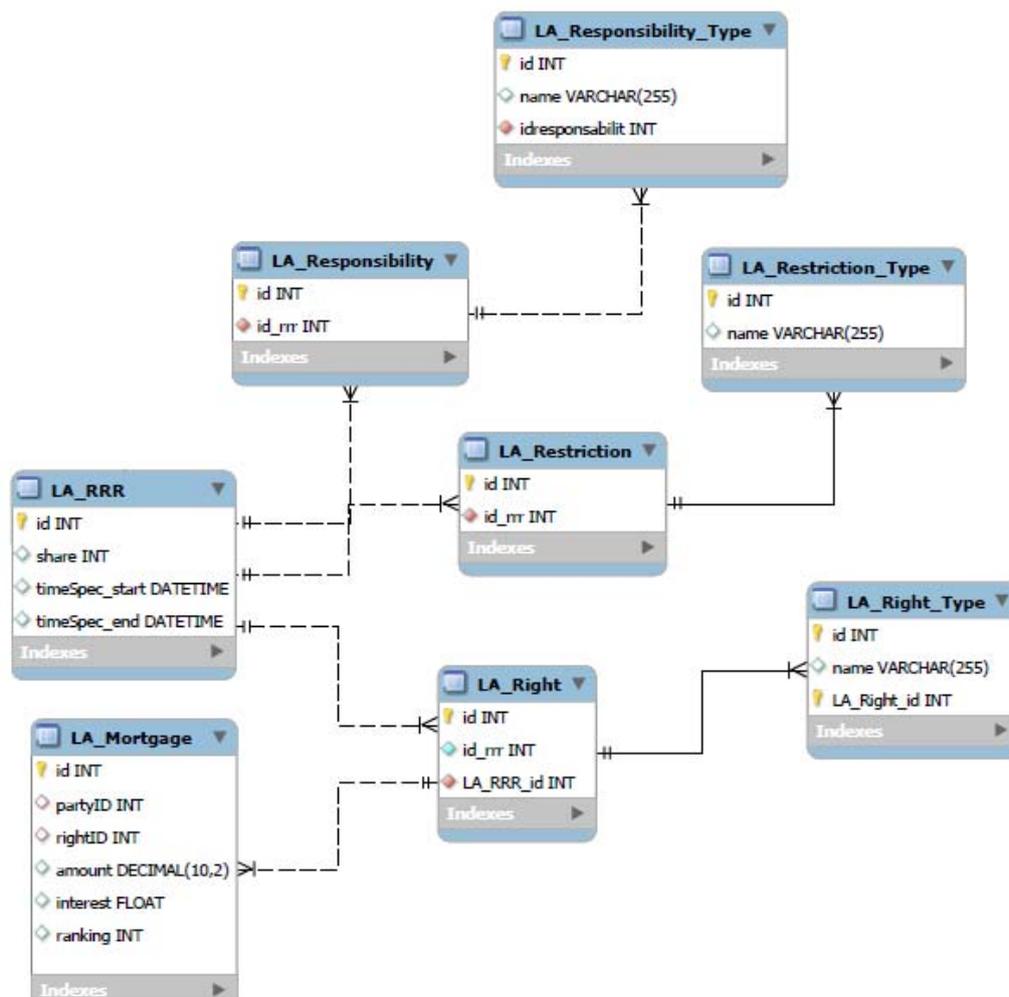


Figure 4. LA-RRR of the LADM

4. RESULTS AND DISCUSSION

The validation of the proposed model was carried out from tests applied to some specific situations. The analysis of the relation between the attribute packages of the LADM and the database of the city hall, was carried out with cadastral data from the city-center to identify the integration between them. The information available in the database of the city hall of

Arapiraca – which was not organized to make possible their automatic insertion in the LADM database – were inserted through SQL directly into the database or manually through an application developed for this end. The details of the methodology and the resources used are described in Santos (2012).

The first to be tested was the LA-Party package, in a situation of a parcel belonging to a group of people, in which each person who has rights over this parcel is a member of a group. In this case, the right is that of inheritance. The situation is illustrated in the diagram of classes presented in Figure 5, which shows the result of the study in the database.

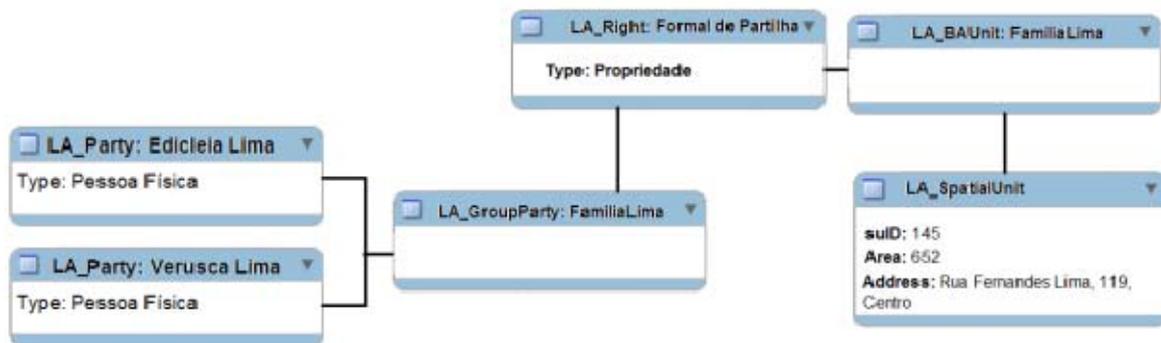


Figure 5. Validation of the modeling of the LA-Party Package

Figure 6 presents the result of the spatial data consultation (LA-SpatialUnit), referring to the previous situation, which indicates the parcel related on the map.

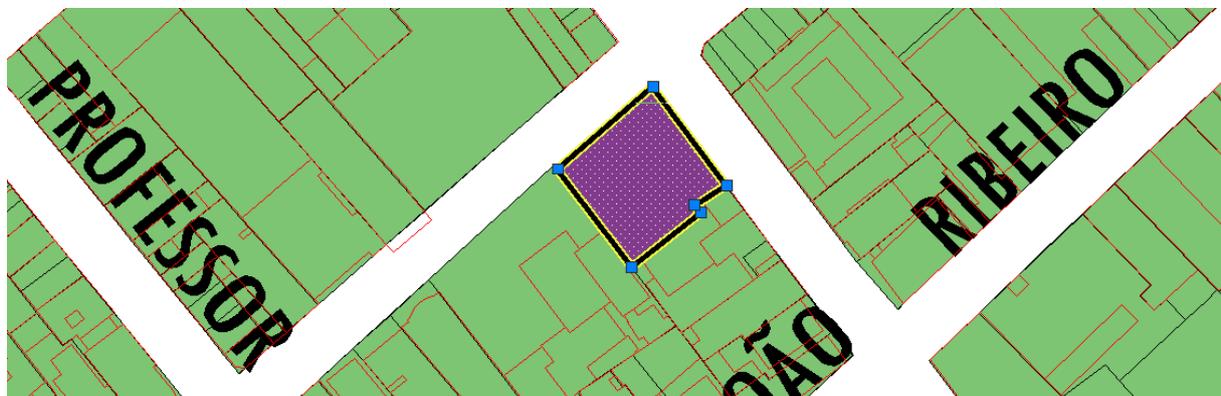


Figure 6. Consultation in the spatial database

For the RRR Package, a mortgage restriction case was tested. The greatest difficulty for the inclusion of this restriction in the cadastral database is that the mortgages are registered in the land registry, which generally is not integrated to the cadastre.

Because the cadastre of Arapiraca includes some mortgage cases, it was decided that the model would be applied on these situations, to emphasize its importance and indicate the necessary actions to systematize the inclusion of this information in the cadastral system.

In the cadastre of Arapiraca, the financed parcels are registered in the name of the tenant, and the financing time period is considered a restriction similar to a mortgage situation, since the right of property is acquired at the moment the debt is paid off. The difficulty of individualizing this situation occurs because this cadastre is identical to the cadastre of other situations of tenure. Also, the database does not contain information regarding time or interest rates related to the contract.

The RRR validation for a mortgage case was carried out from analogical information, by manually inserting the data through an application developed specially for this end. The LA_Party was constituted by the tenant and by the financing institution (*Caixa Econômica Federal*).

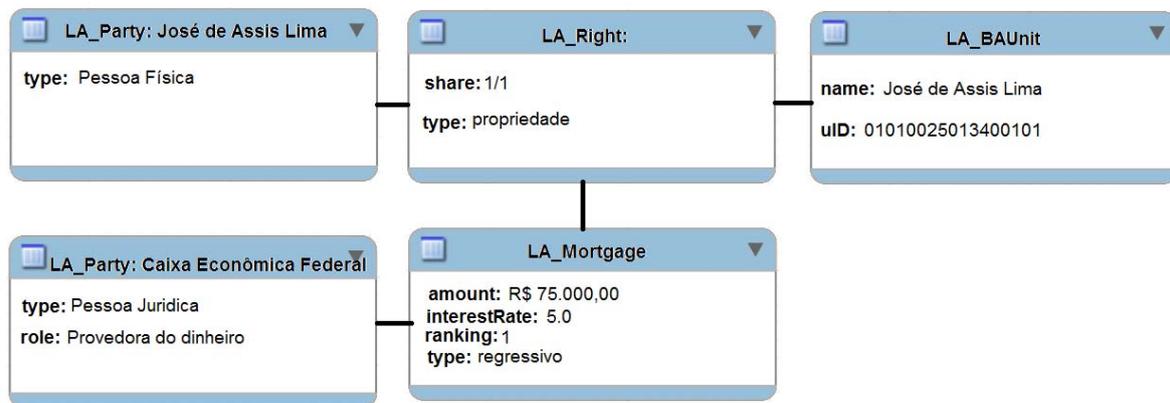


Figure 7. Validation of the modeling of the RRR Package for a mortgage case

Another case of restriction was a situation where a property was declared historical heritage. In Arapiraca only one such case was identified, the Church of São Sebastião, from 1905. The application of the LADM on it is shown in Figure 8. The consultation of the LA_SpatialUnit was satisfactory, indicating the location and characteristics of the parcel.

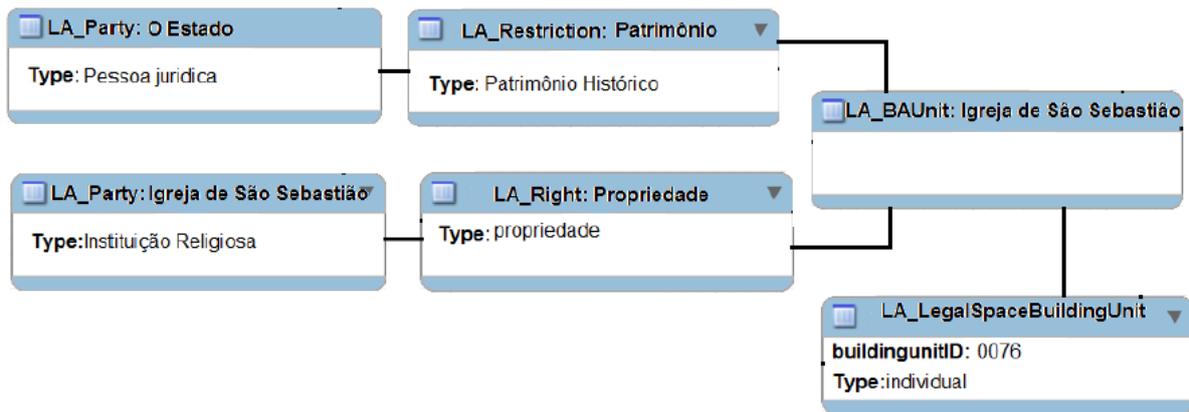


Figure 8. Validation of the modeling of the LA-RRR Package for a case of historical heritage

5. CONCLUSIONS

The study analyzed the viability of applying the LADM on the Brazilian urban cadastre. Despite the diversity of these cadastres, the fundamental elements considered in the LADM are present in most of the systems, which possibilitates testing the model through a case study.

The results of the implementation of the cadastre model of Arapiraca by using the principles of LADM, demonstrated the viability of its use. It is important to emphasize that the LADM was compatible also with the concepts of *Portaria n. 511*, published in 2009 by the Ministry of Cities, as an guideline to the implantation of multipurpose cadastres in municipalities.

This work showed the potential of the model as an instrument to share information – important for the integration of the cadastre to the infrastructure of national spatial data – and also the necessity of understanding the rights, restrictions and responsibilities which are pertinent to each portion of the land.

Brazil still has a long way to go with respect to the standardization of cadastral units and the promotion of the exchange of information with land registries. The dissemination of a model such as the LADM would greatly contribute to the consolidation of a more efficient land administration system.

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REFERENCES

Brasil. (2001). Lei 10267. *Diário Oficial da República Federativa do Brasil*, Poder Executivo, Brasília, 08 dez. 2009. Seção 1, p. 75.

Brasil. Ministério das Cidades. (2009). Portaria n.511, de 7 de dezembro de 2009. *Diário Oficial da República Federativa do Brasil*, Poder Executivo, Brasília, DF, 08 dez. 2009. Seção 1, p. 75.

ISO. (2012). ISO 19152:2012. Geographic information - Land Administration Domain Model (LADM), Geneva, International Organization for Standardization, 118 p.

Carneiro, A.F.T. (2001). Uma proposta de reforma cadastral visando a vinculação entre cadastro e registro de imóveis. *PhD. Thesis*. Florianópolis, 173 p.

Farias, E.S. (2012). Análise das necessidades de usuários para fins de compartilhamento das informações de um Cadastro Territorial Multifinalitário. *MSc. Dissertation*. Recife, 103 p.

Santos, J.C. SANTOS, J.C. (2012) Análise da aplicação do Modelo de Domínio de Conhecimento em Administração Territorial (LADM) ao Cadastro Territorial Urbano Brasileiro - Estudo de Caso para o Município de Arapiraca-AL . *MSc. Dissertation*. Recife, 131 p.

BIOGRAPHICAL NOTES

Juciela Cristina dos Santos holds a degree in Surveying Engineering from Federal University of Alagoas, Brazil, in 2010. In 2012 she obtained an MSc in Geodetics Science from Federal University of Pernambuco, Brazil. She is the coordinator of the GIS division, Prefeitura de Arapiraca.

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