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**International experiences with  
the implementation of the LADM  
(ISO 19152\_2012)**



Dirección de  
**INVESTIGACIÓN**  
y prospectiva

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Land Administration Model – Colombia Volume 1

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## International experiences with the implementation of the LADM (ISO 19152\_2012)

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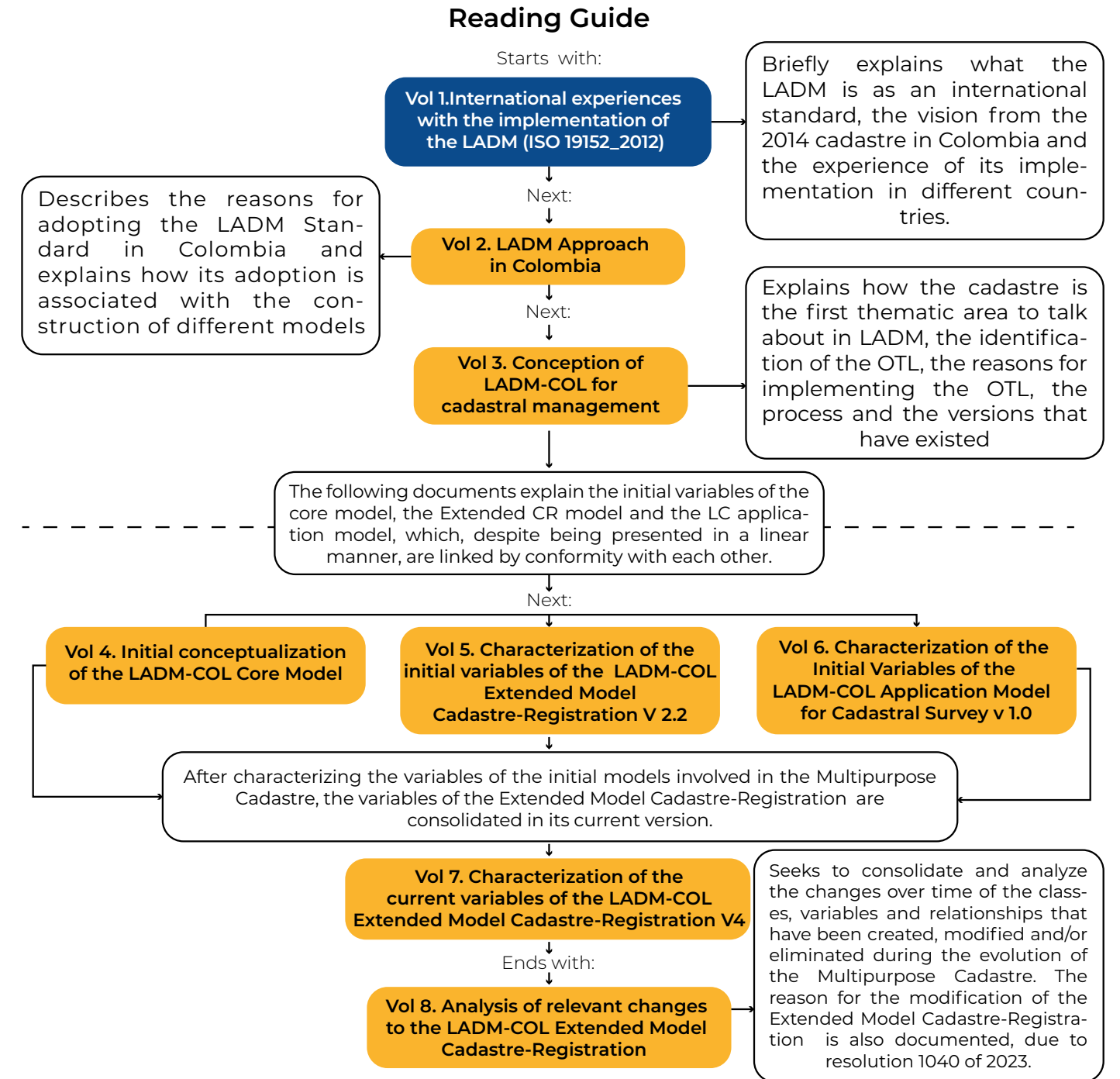
# Preliminary Considerations

The Instituto Geográfico Agustín Codazzi (Agustin Codazzi Geographic Institute –IGAC by its acronym in Spanish–), in its exercise as the maximum cadastral authority, gives the following linear and progressive documents, with the present one being the first. These documents are the result of a research process emphasized in bibliographical review and the generation of documents that could be used as input for the comprehension, development, and promotion of the Land Administration Domain Model (LADM) and the adoption of this one to the Colombian profile, denominated as LADM-COL.

Throughout the document review, it will be possible to encounter diverse technical and methodological analyses of the process, history, changes, and behavior that the LADM-COL Extended Model Cadastral-Registration, and the various application models that surged in the framework of Multipurpose Cadastre, thus seeking to make the cadastral approach the center of these writings so that the various actors of the cadastre and the community in general have within reach a purified and synthetic version of the processes, lessons and current state of the adoption of the models, based on official documentation from the IGAC as the governing body.

Regarding the documentation of these models, it has been observed that if the official information, issued by different national organizations, is contrasted over time, since the conception of the standard's inclusion in Colombia, it may present some ambiguities or appear to be inconsistent in terms of the terminology associated with designated them and the competencies related to them. This corresponds to the institutional development, evolution, and understanding of the implementation of the Land Administration Model in Colombia, oriented towards cadastral management with a multipurpose emphasis.

In the ensuing part is a conceptual map displaying the name of each document, a brief description, and the position that it occupies within the sequence, to delimit its scope and provide the reader with a general overview that allows them to navigate its contents more easily (Figure 1).



**Figure 1.** Reading Guide for Documents Related to LADM Conceptualization in Colombia.

# Introduction

The following document considers an overview of the LADM (Land Administration Domain Model) standard, as a conceptual model for land administration, which has been developed by the ISO/TC 211 (Geographic Information/Geomatics; International Organization for Standardization [ISO], 2012) technical committee. The main objective of the standard is to provide a common semantic framework for data modeling in the land administration process based on cadastral information, which must be interoperable and integrable with other official information systems of each country.

The present document is divided into three main sections:

1. The first section introduces the LADM standard, its history, objectives, application, and structure. The latter is composed of:
  - 1.1 Main packages: Party, Administrative, and Spatial Unit.
  - 1.2 Subpackage: Surveying and Representation.
  - 1.3 Cross-cutting component (abstract class): Document support (Source).

Each of these components represents a different aspect of land administration, such as people's land rights and obligations, administrative processes related to land, physical representation of land, and documentation supporting cadastral data.

2. The second section analyzes the scientific production about LADM, identifying the most frequent topics and the most used methodological approaches. The most frequent methodological approaches in the scientific production on LADM include:

- 2.1 Analysis of Case Studies.
- 2.2 Empirical and experimental evaluation of the standard.
- 2.3 The development of tools and software applications for cadastral

data management.

- 2.4 The definition and application of national or local profiles of the standard.

3. Finally, the third section presents some international experiences of LADM implementation, highlighting the challenges and opportunities that this model poses. The countries that have the most researched and documented success stories are Australia, Brazil, Canada, China, Colombia, France, India, the Netherlands, Spain and the United Kingdom.

Reading on, it will be possible to find that the LADM standard is flexible and extensible, allowing it to be adapted to the different realities and needs of each country or region by defining national or local profiles.

## LADM as an International Standard

The LADM standard was born as a result of a process that lasted more than a decade and involved collaboration among experts, organizations, and countries interested in improving land administration. The main objective of the standard is to provide a common conceptual model for data modeling in the land administration process, based on interoperable cadastral information that can be integrated with the other official information systems of each country. The model seeks to cover and represent the legal, physical, and administrative aspects that exist in the relationship between people and land.

Its beginnings lie in the development process of the LADM standard in 1994 when the technical committee ISO/TC 211 (Geographic Information/Geomatics) decided to create a working group to develop a universal conceptual model for land administration. This group was composed of experts from different countries and disciplines and was based on the review and integration of existing models, as well as the definition of new concepts and relationships.

The first draft of the LADM standard was published in 2003 and underwent several revisions and comments by members of the working group and other stakeholders, until 2012 when the LADM standard was finally approved as an ISO standard (19152:2012), after a voting and review process by members of the ISO/TC 211 technical committee (Van Oosterom and Lemmen, 2015).

The LADM model is flexible and extensible, which allows it to adapt to the different realities and needs of each country or region, by defining national or local profiles (Poyatos et al., 2017). This model is composed of the following elements:

- » Three main packages: Party, Administrative, and Spatial Unit.
- » A subpackage: Surveying and Representation, which is derived from the Spatial Unit Package.
- » A cross-cutting element: Documentary support (Source).

The LADM standard has been the subject of increasing attention in global land administration research and practice, as well as a commitment to the use of international standards to achieve this goal. Since its approval as an ISO standard in 2012, hundreds of articles, books, and other documents related to the standard have been published, covering a wide variety of topics and approaches.

Among the official documents published as results of research, applications, and case studies, among others, the research *LADM- Experiences and Challenges in Implementation* (Govedarica et al., 2018) stands out, in which the authors recognize that the LADM model has indeed improved cadastral management in several ways: On one hand, it provides a common semantic and conceptual framework for the standardization of processes and data, which allows and promotes greater interoperability and integration between different systems and countries. In addition, cadastral data under this standard can be shared and used by any type of interested party with specialized technical knowledge for its understanding, since the manner of exchange can be defined by each entity or state government.

Secondly, LADM is said to have improved the quality and accuracy of the data itself, as it provides a clear and consistent structure for geographic information management. This helps to ensure that the data is accurate, up-to-date, and complete. Finally, the LADM standard has also promoted better accessibility and transparency of cadastral data by promoting public access to the data and providing electronic services to facilitate such management.

Although many countries are making progress in implementing the LADM as a standard ISO 19152:2012, most recognize that it still presents some challenges. These include the lack of knowledge of the model, the lack of financial and human resources for its development, the resistance to change of some governments, the complexity of migrating data from one model to another, and the need for greater collaboration between the different parties or actors involved in such processes.

In addition, the LADM may even require changes to existing regulations and legislation, which can make it an onerous process (Govedarica et al., 2018).

To conclude the description of the international standard, it is important to see how, due to its high impact and importance, the ISO/TC 21 technical committee, together with a group of expert advisors, decided to launch a second edition of the LADM standard, which seeks to add tools and solutions to support marine georegulation, store and make available valuation information and include spatially referenced planning information. This new standard is getting closer to implementation, the remaining is to refine some elements of the edition that were not contemplated and focused only on land registration and/or administration (Lemmen et al., 2023).

### Scientific Production Regarding LADM

Research on the Land Administration Data Model has focused on several key issues including the following:

- » The implementation and application of the standard in different contexts and countries.
- » The interoperability and integration of cadastral data with other official information systems.
- » Evaluation and improvement of the quality of cadastral data.
- » Participation and empowerment of cadastral data users.
- » The relationship between cadastral data and other geographic information systems (Polat et al., 2022).

The most frequent methodological approaches in the scientific production on LADM include the analysis of case studies, the empirical and experimental evaluation of the standard, the development of tools and software applications for cadastral data management, and the definition and application of national

or local profiles of the standard (Polat et al., 2022). Some of the publication sources that discuss LADM are summarized below (Table 1).

Ranking	Name of publication source	Number and percentage of publications based on LADM research
1	FIG Event Count and Review	81 (46.2%)
2	Land use policy	29 (16.5%)
3	International Journal of Geo-Information ISPRS	11 (6.3%)
4	Survey Audit	7 (4%)
5	Class Notes on Geo-Information and Cartography	4 (2.3%)
6	IT Environment and Urban Systems	4 (2.3%)
7	GIM (Magazine of geomatics and other factors) International	4 (2.3%)
8	Other publication sources (17 different)	35 (20.0%)

**Table 1.** Publication Sources with the Highest Participation in Research Based on the LADM During 2012-2020. **Source:** Polat et al. (2022).

According to Polat et al. (2022), 187 institutions were identified, of which 73.3% are academic and 24.7% are not. The top contributing institutions were found to be the Delft University of Technology (59 publications), the University of Twente (32 publications), both from the Netherlands, and the University of Technology Malaysia (22 publications).

These institutions play a crucial role in the development and design of the LADM, as in some cases a collaborative network is formed between the

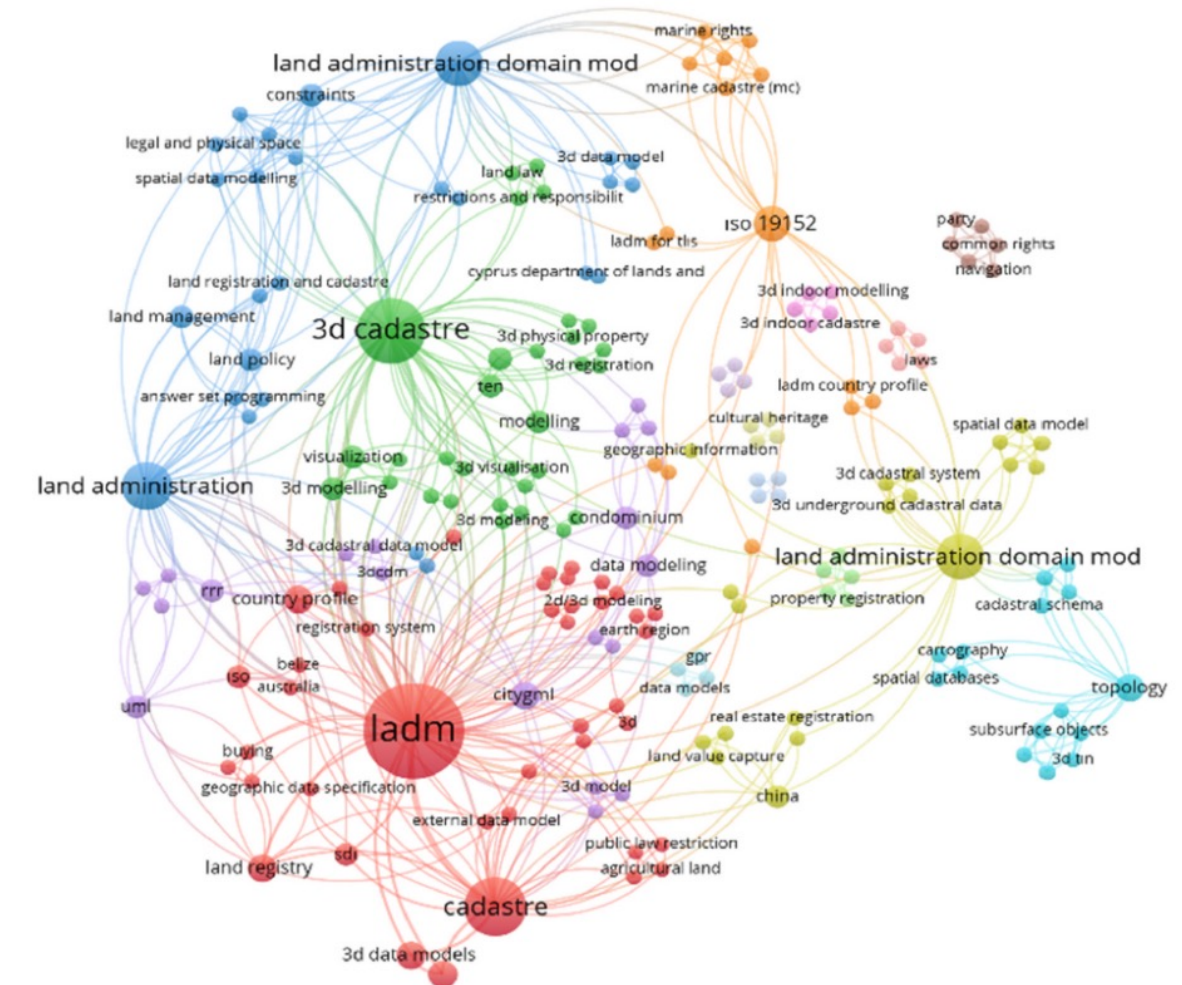


institutions. For example, there is a high level of interaction between the Dutch and Malaysian institutions, as is the case, albeit to a lesser extent, between some institutions in different countries (Table 2).

Ranking	Country	Number and percentage of publications by authors
1	Netherlands	70 (40.0%)
2	Malaysia	25 (14.3%)
3	Greece	21 (12.0%)
4	Turkey	20 (11.4%)
5	Australia	17 (9.7%)
6	Switzerland	11 (6.3%)
7	China	9 (5.1%)
8	Serbia	9 (5.1%)
9	South Korea	6 (3.4%)
10	Portugal	5 (2.9%)
11	Other countries	55 (31.4%)

**Table 2.** Top 10 Countries with the Highest Participation in Research Based on the LADM During 2012-2020. **Source:** Polat et al. (2022).

One element that stands out is the centralization of research based on the LADM in the Netherlands, which, as pioneers and participants in the formulation of the standard, promotes the use and efficiency of this model as the basis for the land administration system. Polat et al. (2022) present an analysis of the publications based on the terms that are most frequently repeated in them, and present, in a system of connected networks, those terms that are most frequently observed in the documents (Figure 2).



**Figure 2.** Thematic Network Involved in the Application of the LADM During 2012-2020. **Source:** Polat et al. (2022).

The figure above shows the network of topics presented in each of these scientific articles and published research related to LADM, from which the following synthesis can be deduced (Table 3).

Country	Addressed Topics
Netherlands	LADM integration in cadastral issues, 3D data modeling, CityGML, and economic valuation of real estate.
Malaysia	Creation of LADM-based country profiles, data visualization, and LADM-based geographic field data collection.
Greece	Creation of country profiles based on LADM and implementation of LADM in the cadastral model.
Turkey	Creation of country profiles based on LADM, land administration, and economic valuation of real estate.
Australia	Creation of country profiles based on LADM and spatial data modeling.
Switzerland	Creation of country profiles based on LADM, implementation of LADM for cadastre, and modeling for the utility network.
China	Cadastre and land register.
Serbia	Utility network modeling based on LADM.
South Korea	Cadastre and economic valuation.
Portugal	Environmental management based on LADM.
Other countries	Creation of country profiles based on LADM, spatial data management modeling, cadastre, and land administration.

**Table 3.** Topics Addressed by Country According to Their Research Related to the LADM During 2012-2020. **Source:** Polat et al. (2022).

Research-based on the LADM standard and its publications worldwide suggests its effectiveness in interoperability, integration, and innovation in the land administration system. Topics such as valuation, spatial data infrastructure, and gender approach, among others, are some challenges that can be explored by implementing a collaborative methodology between LADM and the management model of each topic (Polat et al., 2022).

### LADM International Experiences

Internationally, the LADM has been used in many situations to improve the efficiency of cadastral information management. Among the implementation cases are, for example, the countries of the Balkan region; in Serbia, a cadastral office management and web services module was implemented for the government. On the other hand, in Montenegro, modules for alphanumeric cadastral data maintenance, office management, and customized GIS tools were implemented (Govedarica et al., 2018).

Along the same lines, Australia, Brazil, Canada, China, Colombia, France, India, the Netherlands, Spain, and the United Kingdom have implemented the LADM; however, when the processes are compared, it is possible to see that there are two ends: On one side are countries such as Australia, Spain, United Kingdom, and France, where the implementation was favored by the political and financial support of their governments, which have not only invested in the training of their employees but also developed implementation tools and techniques; likewise, Canada and the Netherlands have had successful and consistent implementations thanks to the organizations actively involved. On the other side are Brazil and China, where there has been a slower process since the land ownership laws of these countries are complex and they must adapt the model to these conditions. It is also worth mentioning the case of India and

Colombia, which have had a slow process due to the lack of available data and the need to integrate data from different sources (Van der Molen et al., 2020).

In general, regarding the implementation scenarios, it can be said that the LADM standard stimulates and accelerates the implementation of open-source land administration systems (Lemmen et al., 2015), in an efficient, effective, and sustainable way (Van Oosterom and Lemmen, 2015).

In the case of Colombia, a project is underway that consists of the development and implementation of a Geoportal for land administration in Colombia, as an initiative led by the Colombian State to modernize land management. Geoportal aims to provide single access to data from different sources, which will facilitate decision-making and the provision of consultation and integration services and geo-services. According to Poyatos et al. (2017), the use of the LADM in the Geoportal will have the following advantages:

» It will improve the interoperability of land administration data: The LADM provides a common view of land administration data, which will facilitate communication and collaboration between different organizations.

» It will ensure consistency of land administration data: The LADM provides a set of standard definitions for different types of land administration data, which will help to avoid errors and misunderstandings.

» It will facilitate the exchange of land administration data: The LADM provides a set of rules for the exchange of land administration data, which will help ensure that data is transferred correctly and efficiently.

Returning to the line of case studies is Indonesia, where Aditya et al. (2021) present a design and implementation of a mobile application focused on property registration, which allows surveyors to collect field data on parcels and their owners following the LADM standard. The application uses the storage format known as *GeoPackage*, in order to collect and synchronize the spatial

and administrative data collected, in addition to connecting with external sensors such as GNSS and fingerprint reader to improve accuracy and data verification. One of the purposes of the application is to validate existing land titles, using what is known as *forensic titling*, which consists of verifying the correspondence between the spatial and legal data of the registered parcels and the paper documents, in order to resolve inconsistencies or gaps through field interviews and photographs of the documents.

The results were analyzed taking into account the usability and efficiency of the application, as well as the quality and consistency of the data; the impact of implementing the LADM standard was also analyzed taking into account the existence of a land administration system with a different data model, finding that the application of the standard facilitates and improves the completeness of the information stored, in addition to integrating in a simple way to any system (Aditya et al., 2021).

Another case of implementation of the LADM is the study conducted in Croatia, whose main theme was the economic valuation of real estate, since data from public records were used to test them in a massive valuation process, using the LADM as a basis. The way in which the valuation modeling is carried out is in two stages: The first, through the identification of matching fields between the LADM standard and existing records; and the second, in the proposal of a data classification based on the reality of the assets and their attributes (Tomić et al., 2021).

The results of the project suggest that the LADM standard and its proposed models can integrate most of the data needed for the mass economic valuation of such assets and that several of them are already included in the models. However, it is determined that for the LADM to function fully, an update of the existing data is necessary, in addition to adjusting the extended models based on the LADM, and for this, it is necessary to incorporate new attributes, define business rules, harmonize concepts and standardize formats within the information management (Tomić et al., 2021).

In Turkey, an attempt was made to test the capabilities of the LADM in the field of economic valuation to develop a process standard. There, a prototype for property valuation was developed, incorporating the conceptual scheme known as the LADM\_VM, which specifies the characteristics and semantics of the economic valuation records and relates them to the cadastre, building registry, housing registry, among others. Property valuation is a part of the land administration system that involves taxation, expropriation, and transactions where land value is paramount (Kara et al., 2021).

The proposal presented was based on the combination of the core LADM adopted for Turkey, the Turkish valuation model, and the proposed version for tax-related valuations, which are recurrent during the year and cover spatial and physical aspects of valuation units, stakeholders in valuation practices and recurrent tax information in Turkey (Kara et al., 2021).

During the implementation of the LADM for valuation in Turkey, UML language design, database schemes, and exchange formats were taken into account. It can also be implemented more efficiently by considering bitemporal aspects, generalization relations, and recurring valuation examples in Istanbul (Kara et al., 2021).

The objective of the project was to evaluate the operability of a prototype land administration system based on the LADM\_VM to guarantee the valuation of properties, in which it was demonstrated that, based on this standard, the prototype was able to successfully handle sample data sets related to real estate valuation, including 3D geometries (another issue to be taken into account) of valuation units and information on historical valuations. As final recommendations of the paper, future research lines are defined that will allow to verify more specifically the LADM standard and its adoption of LADM\_VM for processes related to land administration finding:

- » Tri-temporal modeling based on the LADM\_VM.
- » Advantages and disadvantages of information exchange formats

such as JSON, GEOJSON, GML, RDF, among others.

» Advantages and disadvantages of implementing the LADM\_VM with models such as CityGML, LandInfra/InfraGML, and BIM.

» Feasibility of a 3D visualization and dissemination prototype at the building unit level.

Below is the graph arranged in the article about the data model that was used for the application of the prototype, respecting the conformity of the International LADM standard and the LADM\_VM (Figure 3).

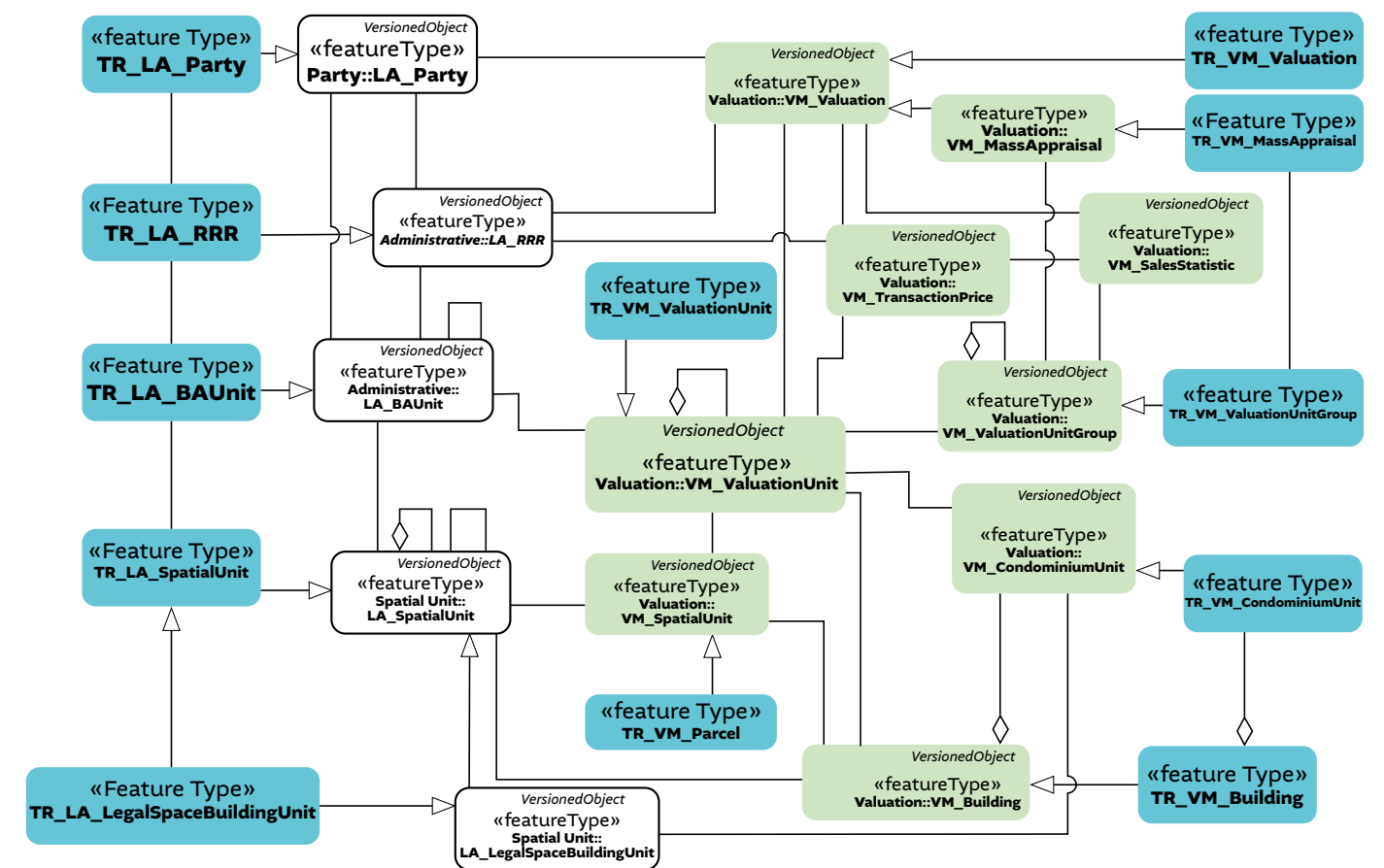


Figure 3. INTERLIS Diagram of the LADM for Valuation. Source: Adapted from Kara et al. (2021).

In addition to the previous examples, it is important to have a step by step a step-by-step for the implementation of the model. According to Van Oosterom et al. (2019), among the steps should be contemplated:

- » Fundamentals of the LADM: In this step, an introduction to the LADM and its key concepts is elaborated.
- » Implementation planning: Advises on planning a successful implementation of the LADM.
- » Implementation design: Proposes advice on the design of a specific LADM to be implemented.
- » Implementation of the implementation provides tips for implementing the data, processes, tools, and techniques of the LADM.
- » Implementation operation and maintenance provides tips for the operation and maintenance of the LADM implementation.

During the preparation of the proposal, a holistic vision of territorial information management is built, since the LADM model is not limited to geospatial information, but also includes legal, financial, and administrative information. This allows for a more complete view of land ownership and use.

It is demonstrated that the LADM\_VM is capable of representing the information required and produced in recurrent valuation processes and that it can facilitate integration and interoperability between land administration systems, provided that stakeholders are actively involved. Finally, Kara et al. (2021) suggested expanding the scope of the country's LADM country profile to cover other valuation purposes, testing the prototype with a larger, real-world prototype with larger, real-world datasets, and comparing the LADM\_VM with other existing with other existing international models to observe and understand opportunities for improvement.

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