Formalisation of Cadastral System Data Dissemination Processes – Initial Studies

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Key words: cadastral processes, data dissemination, LADM, modelling, cadastral system users

SUMMARY

The land administration system and its key registers, cadastres and land registers, play an important role in society when they function and meet the goals set by the society. For the land administration system to be effective it is important to have well-defined static and dynamic components of the system. Static and parts of the dynamic components of the land administration system are defined by the ISO 19152 LADM standard, but for the purposes of efficiency and functionality of the system, process optimisation is also important. The aim of this paper is to explore the processes of cadastral system data dissemination regarding standardised and non-standardised uses of cadastral system data. Formalisation of processes is one way to explore which of the existing classes of the LADM can be used in process modelling and which ones need to be modelled in the future editions. By formalising the processes of cadastral system data dissemination, the first step in modelling the process is achieved, which is the identification of participants and their roles in the processes of cadastral system data dissemination. By identifying process participants and their requirements, the user profiles can be developed in accordance with the LADM standard, all for the purposes of future process modelling, which is planned as an extension to the current edition of the LADM.

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1. INTRODUCTION

Cadastres and land registers or, taken together, the cadastral system, are public registers founded on the principle of publicity and are obliged to grant access to registered information to a wide range of users. In addition to citizens and public authorities, who recently have been the most common users of cadastral system services and data, the cadastral system is being used more and more in other economy branches, such as the real estate market, spatial planning, taxation etc. and is becoming the foundation of spatial data infrastructure. Many other experts have upgraded cadastral system data with their new sets of data which are derived from cadastral system data or created in accordance with it. The right of access to public data is guaranteed by law in many countries worldwide, and despite the fact that these countries and laws are different, their goals are the same, namely population awareness, democracy growth, fighting against corruption and raising responsibilities of governing structures. Complex patterns, processes and regulations slow down activities and raise discouragement for dissemination of the cadastral system data (Roić, 2012).

Urbanisation, changing population demographics, advances in technology and other major global trends are affecting every individual and organisation around the world. Collaboration and data exchange are very important in all economy branches including the land administration systems. Cadastral system registers, as one of the key registers of land administration systems, play a role in granting access to land information and maintaining cadastral system data in accordance with transactions that occur on land (Krigsholm, Riekkinen and Stahle, 2018).

Using cadastral system data is regulated by law; from the regulations it is necessary to define user requirements by formalising the use cases, which must then be checked in terms of whether they are in accordance with both user requirements and regulations affecting cadastral system data (Navratil and Frank, 2004).

The conceptual model describing land administration systems is known as the Land Administration Domain Model (LADM), which became the ISO 19152 standard. The LADM represents the basis for modelling static components of the system and these models do not include land administration processes for initial data acquisition, data maintenance and data publication. This is because these processes were considered to be country-specific when the first edition of the LADM was prepared; a generic and global approach was likely to be difficult to model. This view may now need reconsideration (Lemmen *et al.*, 2017). According to the documents relating to the new scope of proposals for the LADM revision, processes are yet to be modelled and are planned as an extension to the current version of the LADM . It is also important to acknowledge that these are only proposals and need to go through the ISO

consensus process before becoming part of the new standard (Lemmend *et al*., 2019; van Oosterom *et al.*, 2019).

Traditionally the focus of the research on land administration systems was pointed towards defining static components of the system and the provision of its data; therefore, it could be stated that there was not enough research in the field of dynamic components of the land administration systems, which are represented with methodologies of updating large sets of data with transactional properties such as the data stored in cadastral systems. It is more meaningful to talk about cadastral systems than cadastres or land registers, as these systems, due to their complexity and wide range of processes support the interaction between land parcels, registration of land rights, valuation and taxation of land and many other current and future uses (ISO, 2012; Roić, 2012; Krigsholm, Riekkinen and Stahle, 2018; Vranić, 2018).

The aim of this paper is to formalise processes of standardised and non-standardised uses of cadastral system data.

Standardised uses, in this paper the cadastral system excerpts, are those defined by the legislation and required by other authorities; they can usually be purchased from the cadastral system authorities. Non-standardised uses are more user-specific, in terms of formats and ways of accessing the data; they are also affected by legislation in terms of what data can be used by others and for what purposes. Formalisation of processes will be conducted using UML activity diagrams, as UML has proven to be a good tool for modelling cadastral processes (Arvanitis and Hamilou, 2004; Lisec, Miran and Šumrada, 2007; Zevenbergen, Frank and Stubkjær, 2007; Vučić and Roić, 2014).

The main goal of process formalisation is to establish connections with existing LADM classes for specific process parts and roles in order to determine which classes are already modelled and which need to be modelled in the future editions of the LADM. It is important to stress that the processes formalised in this paper are somewhat country specific but are formalised more in a general sense. Actors and process elements can vary from country to country and are subject to different laws and procedures. Models developed in this paper are based on experiences of authors and do not represent the broader land administration domain. The standardized cadastral system excerpt used in this paper, as an example, was retrieved from the Joint Information System (URL1), the platform where cadastre and land register (cadastral system) are incorporated as part of the land administration system and the stored data is electronically available to its users.
In order to gain insight knowledge regarding cadastral processes and their data, thorough examination of previous research was conducted. The examined research will also be mentioned in the paper. The paper is organised as follows: in the first part, previous research on the topic of processes will be listed, as will the results achieved thus far. In the second part of the paper user requirements, activities and cadastral system data will be described. The next part will include the formalisation of the cadastral system data dissemination processes and connection with the LADM. Paper ends with a discussion and conclusion regarding the results achieved.

2. RESEARCH OF CADASTRAL PROCESSES

This paper focuses on one domain of cadastral system dynamism, and it is represented by the dissemination of the data. To date, however, most of the research on cadastral systems has been pointed towards static components (the Core Cadastral Doman Model and later the LADM) and provision of data, focusing more on technical and legal issues of the system.

A solid basis for process modelling in cadastral systems was provided by the COST Action G9 'Modelling Real Property Transactions' (Zevenbergen, Frank and Stubkjær, 2007). COST Action G9 provided comparative analysis of the economic efficiency of transactions in the real estate market and connections between costs of transactions and various national practices regarding real estate processes. Important results from aforementioned action were the definition of terminology, legal and technical correctness criteria, efficiency of transactions (direct and indirect) and general process stages.

Navratil and Frank (2004) analyse cadastral systems (types, organisation, data and stakeholders) and the processes that affect them. They define two general types of processes in cadastral systems, namely inscription and retrieval of data. Inscription adds new documents to the register and retrieval of data returns information to the user. The authors stated that data requests must allow different keys, because it is not granted that there is a single key suitable for all requests (e.g. parcel identifier). They also stated that the first step in the process of data retrieval is to test whether the request is allowed or not, therefore the request is calculated only if said request is allowed. The authors also listed some examples for search criterion keys, namely identifier of parcel, postal address of the parcel and the name of a person owning the land; it was however, noted that using the name of the owner as a search criterion may be restricted by law.

Sari (2010.) analysed the process of maintenance of cadastral data in Indonesia, where using the example of parcel subdivision the author developed an activity diagram and pointed out which LADM classes take part in the process. Krigsholm, Riekkinen and Stahle (2018) conducted a survey regarding current and future uses of Finnish LAS; indeed, the authors pointed out the challenge for cadastral systems in terms of data provision regarding accuracy, reliability and provision in real time. The temporal component of data is stressed as very important to almost all users.

The Open Geospatial Consortium (2019) pointed out that interoperability, data sharing and data integration are needed in land administration development. Services and links to external databases must be able to support operations in internet-connected environments as well as disconnected environments as the internet is not reliable in all areas.

The aforementioned research papers indicated that user requirements, process information, data maintenance, publication and transparency of processes are of the utmost importance for the future development of land administration systems.

3. CADASTRAL SYSTEM – DATA AND ACTIVITIES

Land administration is built around cadastres and land registers, or, taken together, cadastral systems. It is often more meaningful to talk about cadastral systems, as these systems describe the interaction between the basic block in any land administration system, namely land parcel, as identified in cadastres, the registration of land rights, the valuation and taxation of land parcels, and other present and future uses of land (Enemark, Williamson and Wallace, 2005).

Modern land administration systems in developed countries should be able to support sustainable development – economic, social and environmental sustainability – through public, transparent and responsible decision making on built and non-built space (Bennett *et al.*, 2012). In order to connect land administration systems, such as cadastral systems, with public and private users, information technology solutions need to be implemented in order to enable users to access cadastral system data and use it in accordance with their needs and law restrictions. Examples of such solutions could be built through multipurpose land administration systems (MLAS), where it would be possible for various users, in accordance with their needs but also rights and restrictions, to have access to land information in order to use the data or to produce new information based on existing land data.

Cadastral systems deal with subjects, objects and rights as a connection between subjects and objects. Cadastres provide data on land, and most of the stored data (e.g. ownership) relates to people. Rights are an idea, not a physical object and they define what the subject can do with the object, or in the case of the cadastral system, what the owner can do with his/her land parcel (Navratil and Frank, 2004). Figure 1 represents the four core LADM classes, and as it shown, the connection between subjects (LA_Party) and objects (LA_BAUnit) is established with real rights (LA_RRR).

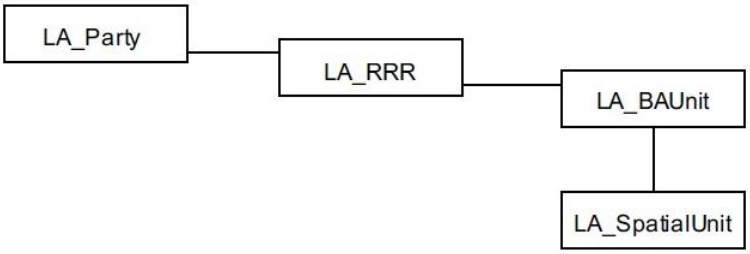


Figure 1 – Core classes of the LADM (ISO, 2012)

Subjects can be legal entities and natural persons; objects are land parcels defined with a unique identifier (e.g. parcel ID), which is used to establish connection via rights with subjects who must also have a unique identifier, such as a personal identification number (PIN).
Users of cadastral system data (subjects) are defined with the class LA_Party, and they do not have to be stakeholders of land parcels in order to browse and use the data. For the purposes of identifying users of cadastral system data as instances of the class LA_Party, it is necessary to identify their needs but also rights and restrictions for dissemination of cadastral system data. Identification of users and their needs, roles and activities can be depicted using UML use case

diagrams or activity diagrams. In this paper, activity diagrams for standardised and non-standardised cadastral system data dissemination processes were developed.

4. FORMALISATION OF CADASTRAL SYSTEM DATA USE CASES

Land administration could be defined as management of land tenure, land valuation, land use and land development (Enemark, Williamson and Wallace, 2005; Bennett *et al.*, 2012). As cadastral system data is the core data for land administration, it is expected that it will be required and employed by other land administration system users. In order to explore current and future needs for cadastral system data, it is necessary to formalise the data dissemination processes and define roles, activities, input and output data, rights, restrictions and responsibilities of actors in the system.

Generally, the process of using data requires a minimum of two actors, a provider and a user, as well as a minimum of three activities, data provision, retrieve and use (Figure 2). In cases of using cadastral system data, the process cannot be considered in such a simple way.

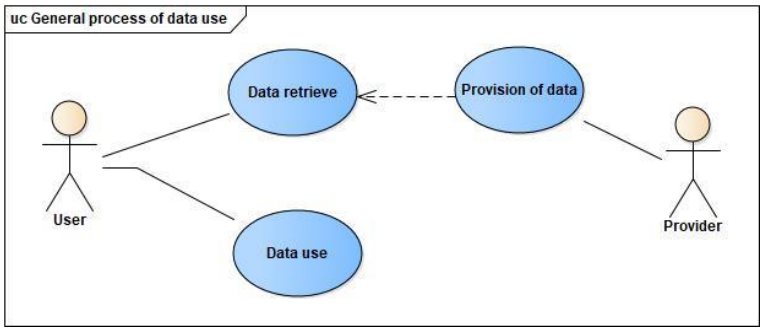


Figure 2 – General methodology for process of using data

The use of cadastral system data is regulated by legislation, meaning that access to some information may be limited to different users or the payment of a certain fee is necessary for the required data. Furthermore, various users will require data in formats that are best suited for their use intention. Some users may require the data to be verified, while some may not, and others might require the data to be provided in real time or at a specific date and time.
The aforementioned requirements could be explored through formalisation of cadastral system data dissemination processes. The general methodology of process modelling is of a hierarchical nature. Following a study by van Oosterom *et al.* (2019), the authors suggested the below four steps/levels in process modelling:

- Level 1 – Identification of all the actors/elements involved in a process according to the specified elements
- Level 2 – Identification of process phases, i.e. groups or sub-processes relating to a certain topic and provision of generic descriptions
- Level 3 – Identification of basic activities
- Level 4 – Building of a model

In this paper the focus is on formalising the Level 1 step using examples of standardised and non-standardised use cases of cadastral system data and to connect its parts with existing

LADM classes. An example of standardised use case would be the retrieval of cadastral system excerpts, while an example of non-standardised use case of data would be data retrieval for the purposes of spatial planning.

4.1. Standardised use of cadastral data

A cadastral system is made up of public registers founded on the principle of publicity and said registers are obliged to grant access to registered information to a wide range of users. Thus far, the most common users of cadastral system data have been citizens and public authorities. In order to fulfil their requests for data, standardised excerpts were developed, such as excerpts from cadastral map and register data or any other cadastral system data unless it is differently regulated by the legislation.

The first example of cadastral system data use is standardised use case in terms of requests for excerpts of cadastral map or register data. This process is demonstrated by means of an activity diagram (Figure 3).

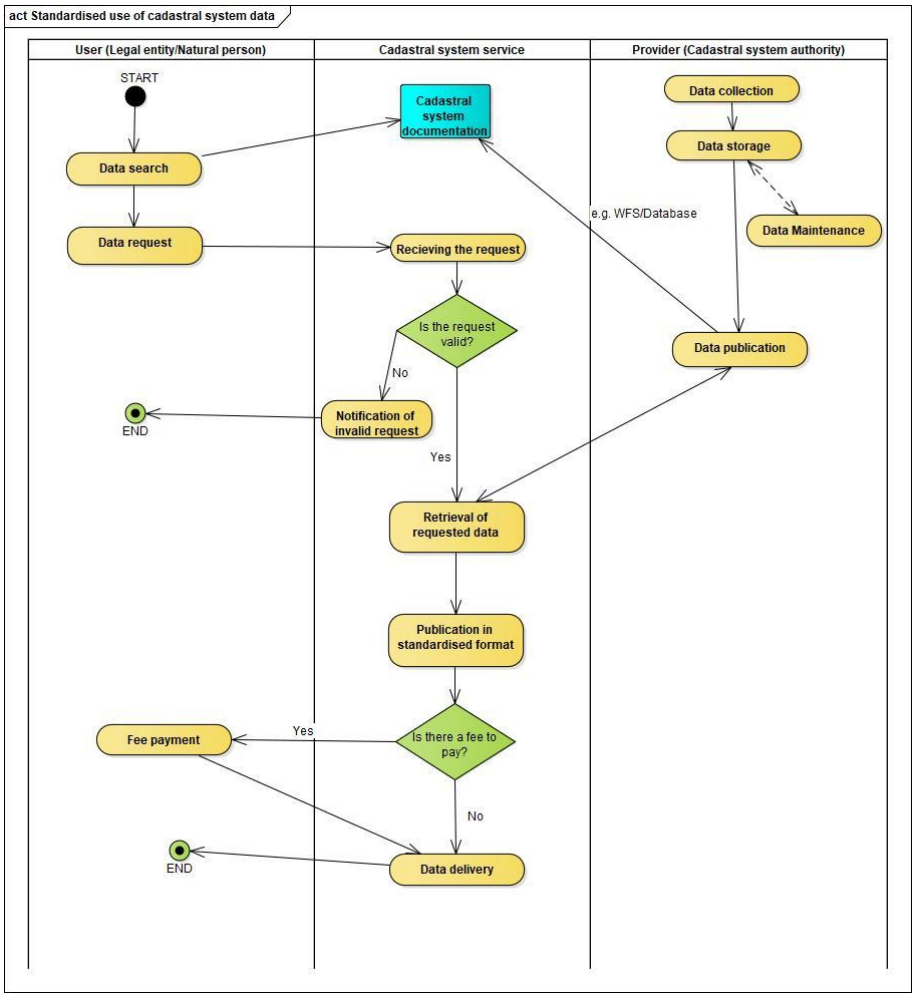


Figure 3 – Standardized use of cadastral system data

In the activity diagram, shown in Figure 3, two main actors are identified for the process of standardised use of cadastral system data, namely user (legal entity/natural person) and provider (cadastral system authority) who communicate through the cadastral system service. Public entities or natural persons constitute the interested party or initiator in this process and the role of supervision and execution of the process is in the domain of the cadastral system service operated by the cadastral system authority. The input data of this process is generated by both previously mentioned actors. The data request made by the legal entity/natural person is submitted after the search for data, which is enabled by the publication of data by the cadastral system authority via, e.g., WMS/WFS and database access depending on what type of data is requested for inspection and retrieval. Output data, the standardised excerpts or notification of an invalid request, are provided by the cadastral system service after a series of actions have been completed. The actions required to fulfil the data request made by the process initiator are validity check, connection to cadastral publication system, publication of requested data in standardised format, check for fee requirement and, finally, delivery of requested data to the process initiator.
The formalised process indicates the need for development of user profiles in accordance with legislation because the very first step in data retrieval is the validity check in terms of whether the initiator of the process is able to retrieve the requested data. A standardised format for the output data (excerpts) is also very important, because the data must be delivered in a form accepted by the process initiator, e.g. in .pdf format. Data publication should also be in accordance with the user requirements and it must enable easy access to, and searches for, cadastral system data.

4.2. Non-standardised use of cadastral data

Modern land administration systems, including cadastral systems, are expected to support sustainable development in terms of economic, social and environmental sustainability. The need for cadastral system data has risen from its original purposes. Many users combine cadastral system data with their sets of data, which are either derived from cadastral system data or created in accordance with it. These new user requirements for cadastral system data can be described as non-standardised uses of cadastral system data. In this paper, example of non-standardised use cadastral system data is for the purposes of spatial planning and it is also formalised by means of an activity diagram (Figure 4).

Why are these uses of cadastral system data termed non-standardised? The main reason would be because they transcend the initial purpose of cadastral systems and affect many other processes which are unrelated to the cadastral system. A good example of the non-standardised use of cadastral system data is for the purpose of spatial planning. In order to reach the multipurpose level of the land administration system, data interoperability and consistency are critical. A spatial plan is considered to be very important for cadastral system users, as many processes concerning land parcels are regulated by the spatial plans and regulations pertaining to spatial development (e.g. subdivision of land parcel). In the activity diagram, shown in Figure 4, the process for access to the use of cadastral system data is described. Access can be granted via any service such as WFS or database connection.

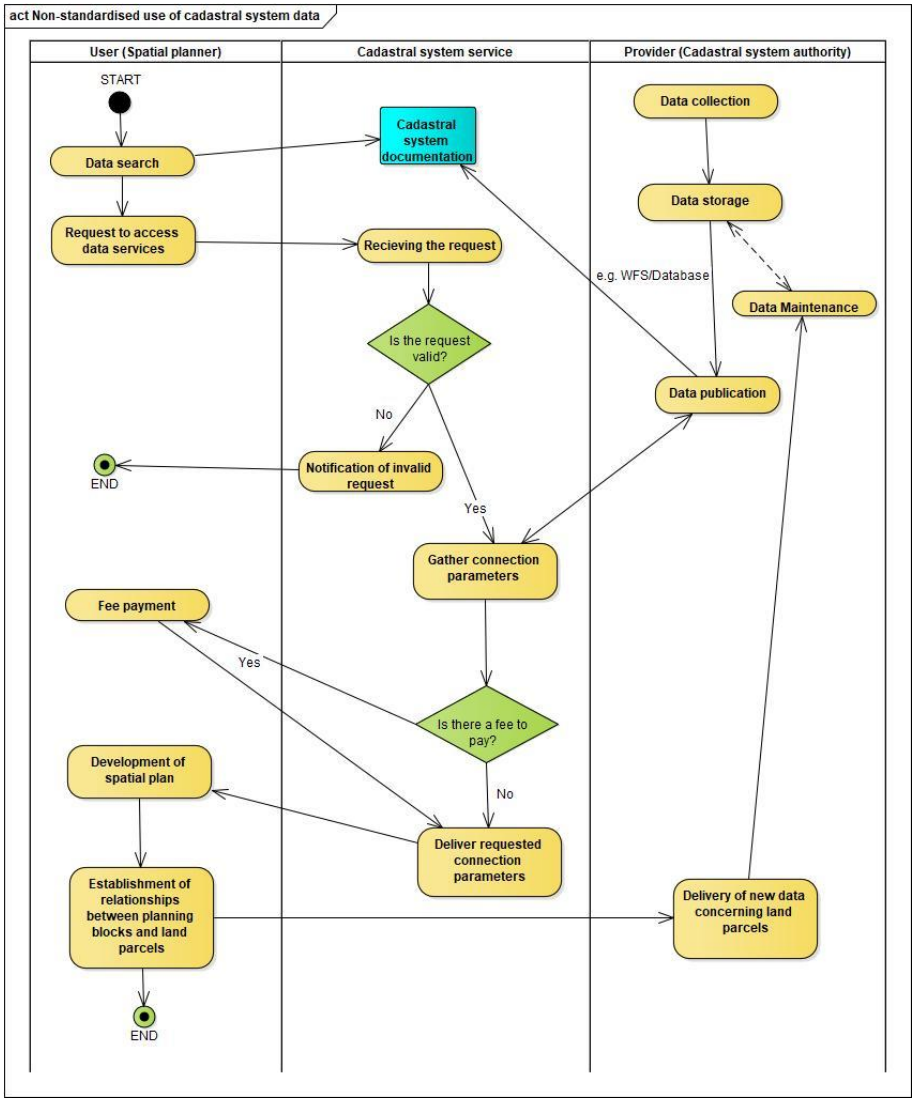


Figure 4 – Non-standardised use of cadastral system data

The formalised process of the non-standardised use of cadastral system data in this example identifies two actors communicating through the cadastral system service. The initiator of the process is the spatial planner who inspects published cadastral system data and then requests to access the data via the service in order to develop a spatial plan and to establish relationships between planning blocks and land parcels registered in the cadastral system. The role of supervision and execution for the process of accessing cadastral data is in the domain of the cadastral system authority operating through the cadastral system service. Input data in this process is generated by both actors, and is represented by published cadastral system data and generated requests for accessing the data. Output data, concerning the connection parameters of the required service, is generated by the cadastral service after the series of actions have been taken. Actions required to fulfil the requested access in this process are request validity check, connection to data publication system, check for fee requirement and, finally, the delivery of connection parameters to the spatial planner. The process does not end with the delivery of connection parameters because after the development of the spatial plan, new set of data

concerning land parcels can be generated and it is represented by relationships between planning blocks and land parcels, which can later be delivered to the cadastral system authority in order to update the current data with new data.

The formalised process of the non-standardised use of cadastral system data also points out the need for user profile development in accordance with legislation and user requirements. It is necessary for the cadastral system to explore a variety of user requirements in terms of accessing data in order to deliver the data in the most appropriate format. Since the access to cadastral system data is required by other public authorities and legal enterprises, in order to develop new land data which may concern cadastral system data transactions, it would be possible to develop registered user profiles with user-specific rights and restrictions for data access.

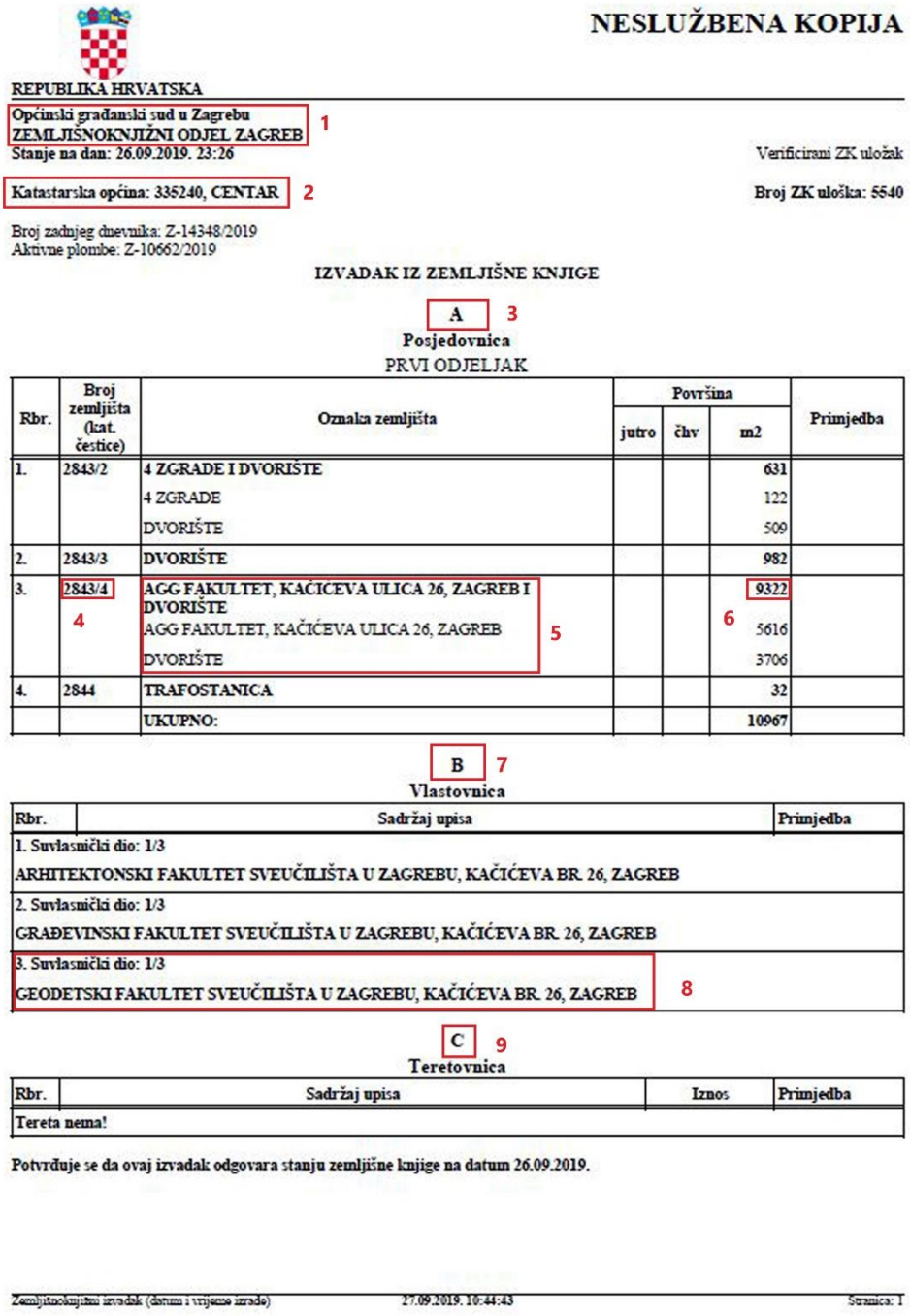
4.3. Identification of LADM classes with formalised processes

Updates of, and changes to, cadastral system data may concern the following: parties and their attributes, rights, restrictions and responsibilities and related attributes, basic administrative units and related attributes, and spatial units and related attributes. More generic process-related modules in data acquisition and data handling as well as maintenance and publication are needed. Process information is information on who must do what in approving the transaction. The LADM has already included a series of dates for interaction with the process, but the current edition of the LADM does not include processes for data acquisition, maintenance and publication. The connection of existing LADM classes with formalised processes will be demonstrated on an example of a standardised cadastral system excerpt for a cadastral parcel on which is the Faculty of Geodesy at the University of Zagreb, Croatia located (Figure 5).

In the standardised cadastral system excerpt, shown in Figure 5, it is possible to establish connections with core classes of the LADM. It must be noted that the excerpt is provided only in the Croatian language, and so the parts of the excerpt which relate to the LADM are marked with red rectangles and numbers next to them. The excerpt was provided in .pdf format and anyone can request it via the Joint Information System.

Number 1 in the Figure 5 represents the office in charge of the maintenance of data shown in the standardised cadastral system excerpt, which is the Land Register Office for the city of Zagreb, and is under jurisdiction of the Municipal Civil Court Zagreb. The authority in charge of the maintenance is denoted by the class LA_Party. Number 2 represents the cadastral municipality where the cadastral parcel is located, and in this case it is Cadastral Municipality Centre with its unique identifier. The cadastral municipality is denoted by the class LA_SpatialGroup. The following number (3) refers to the part of the excerpt where the information about land parcels and their descriptions is registered. Number 4 represents the cadastral parcel ID, where the Faculty of Geodesy is located (2843/4), and it is denoted by the class LA_BAUnit. Numbers 5 and 6 refer to the description of the cadastral parcel in terms of land use, address and area and are referred to b the class LA_SpatialUnit. Proprietorship is noted in the part of the excerpt represented by the number 7, and the owners of the cadastral parcels registered in this excerpt are the Faculty of Geodesy, Faculty of Architecture and Faculty of Civil Engineering which have equal shares of 1/3. The owners are denoted by the

class LA_Party. The third part, marked with the number 9, of the excerpt is reserved for charges such as mortgages, which are denoted by the class LA_Restriction but in this example there are no registered charges.



NESLUŽBENA KOPIJA

REPUBLIKA HRVATSKA

Općinski građanski sud u Zagrebu
ZEMLJIŠNOKNJIŽNI ODJEL ZAGREB 1
Stanje na dan: 26.09.2019. 23:26

Verificirani ZK uložak

Katastarska općina: 335240, CENTAR 2

Broj ZK uloška: 5540

Broj zadnjeg dnevnika: Z-14348/2019
Aktivne plombe: Z-10662/2019

IZVADAK IZ ZEMLJIŠNE KNJIGE

A 3
Posjedovnica
PRVI ODJELJAK

Rbr.	Broj zemljišta (kat. čestice)	Oznaka zemljišta	Površina			Primjedba
			jutro	čhv	m2	
1.	2843/2	4 ZGRADE I DVORIŠTE			631	
		4 ZGRADE			122	
		DVORIŠTE			509	
2.	2843/3	DVORIŠTE			982	
3.	2843/4 4	AGG FAKULTET, KAČIĆEVA ULICA 26, ZAGREB I DVORIŠTE			9322 6	
		AGG FAKULTET, KAČIĆEVA ULICA 26, ZAGREB 5			5616	
		DVORIŠTE			3706	
4.	2844	TRAFOSTANICA			32	
		UKUPNO:			10967	

B 7
Vlastovnica

Rbr.	Sadržaj upisa	Primjedba
1. Suvlasnički dio: 1/3	ARHITEKTONSKI FAKULTET SVEUČILIŠTA U ZAGREBU, KAČIĆEVA BR. 26, ZAGREB	
2. Suvlasnički dio: 1/3	GRAĐEVINSKI FAKULTET SVEUČILIŠTA U ZAGREBU, KAČIĆEVA BR. 26, ZAGREB	
3. Suvlasnički dio: 1/3	GEODETSKI FAKULTET SVEUČILIŠTA U ZAGREBU, KAČIĆEVA BR. 26, ZAGREB 8	

C 9
Teretovnica

Rbr.	Sadržaj upisa	Iznos	Primjedba
Tereta nema!			

Potvrđuje se da ovaj izvadak odgovara stanju zemljišne knjige na datum 26.09.2019.

Zemljišnoknjižni izvadak (datum i vrijeme izrade) 27.09.2019. 10:44:43 Stranica: 1

Figure 5 – Example of standardized land register excerpt

Using the abovementioned example, several process elements were identified in accordance with the LADM, such as output data, format of data, providing service and authority in charge

of maintenance of data. Further connections between the LADM and process elements were suggested by van Oosterom *et al.* (2019) and are as follows:

- Interested party, or initiator of the process, is denoted by the class LA_Party.
- Executing and supervising party is denoted by the class LA_Party.
- The input and output data of the process, whether legal (deed/title) or spatial (map) products, depend on the type of the process and can be represented by either LA_Source, both spatial and administrative, but some processes may include special units as their input/output and hence correspond to LA_SpatialUnit.
- A format or a procedure of data exchange, submission or distribution required for the process may be depicted by sources' attributes such as mediaType.
- Restrictions and constraints, which are characteristic in a given process, may be formed as constraints in the LADM model.
- The legal basis relating to the process may be represented in the LADM by the LA_AdministrativeSource class

The actions which need to be taken during the process, such as validity check, data retrieval, fee payment, delivery of data etc. are not modelled with existing LADM classes. The identification of LADM classes with the process of non-standardized cadastral data uses requires more in-depth research and modelling. Detailed analysis of non-standardised cadastral data uses is planned in the future as an extension to this paper, and for the further development of the model, consultations with included stakeholders and users should be conducted.

5. DISCUSSION

It is well known that interoperability, data sharing and data integration are needed in the development of land administration. Land administration systems are built around cadastral systems, so the first step in achieving the abovementioned needs for LAS development is the identification of user requirements for cadastral system data. User requirements can be grouped into two main aspects, namely technical and organisational.

The technical aspect is represented by the process procedure, time, cost, service, information system and technology. According to Sari (2010) user requirements in terms of the technical aspect are: need for one stop shops, need for accelerated/quicker process time, need for up-to-date, accurate, valid and transparent data and system archive, need for online registration processes, customer satisfaction and fee reduction.

Organisational aspect of the user requirements is related to human resources and regulations supporting the processes of land administration, while the LADM supports the document exchange in the electronic environment, therefore some of the processes could be automated via internet services.
After examination of the two formalised processes in this paper and the aspects of user requirements, certain questions could be raised in order to aid in modelling cadastral system data dissemination processes.

Those questions would be:

- Who are the actors in the process?
- What are the actors' roles in the process?
- Where can the published data be accessed?
- What are the user requirements and are they in accordance with legislation?
- What are the necessary actions to fulfil user requirements?
- What is the purpose of requested data?

By answering these questions, the main actors, user requirements (e.g. desired data format) and steps for process automation and control could be established.

6. CONCLUSION

Meeting user requirements is a growing challenge for all the economy branches and land administration systems. Cadastral systems, as the core registers and services in land administration systems, must also respond to the growing number of user requirements for cadastral system data.

Design and analysis of user requirements, through formalisation and process modelling, is one way to gain insight into the needs for cadastral system data in order to provide data in the most suitable format. Reliability, availability and dissemination of cadastral system data is crucial for business enterprises and the public sector in order to produce new sets of data or to upgrade existing data with new information.

Identification of user requirements for cadastral system data can lead towards standardisation of user profiles, whose rights, restrictions and access to data, could be modelled in accordance with the LADM. From formalised processes of cadastral system data dissemination, certain steps in developing required data interoperability, sharing and integrity could be achieved.

In terms of process modelling, as mentioned, the very first step is the identification of actors and elements of the process. It is important to stress that the actors and process elements might differ from country to country because they are subject to enforced laws and accepted procedures. Because of these differences, it is essential to formalise processes for country specific cases in order to gain more in-depth insight into process differences for the purpose of process modelling and standardisation, which are planned for future development of generic LADM processes.

Finally, the growing demand for cadastral system data points towards the need for more explicit process modelling, detailed class diagrams, and more research in the field of cadastral system data dissemination processes.

REFERENCES

Arvanitis, A. and Hamilou, E. (2004): Modelling cadastral transactions in Greece using UML, in Proceedings of the FIG Working, pp. 1–10. , Athens, Greece

Bennett, R., Rajabifard A., Williamson I., and Wallace J. (2012): On the need for national land administration infrastructures, Land Use Policy, 29(1), pp. 208–219. doi: 10.1016/j.landusepol.2011.06.008.

Enemark, S. and Williamson, I., Wallace J. (2005): Building modern land administration systems in developed economies, Spatial Science, 50(2), p. 19

ISO (2012) Geographic Information - Land Administration Domain Model (LADM) - International standard ISO 19152.

Krigsholm, P., Riekkinen, K. and Stahle, P. (2018): The Changing Uses of Cadastral Information: A User-Driven Case Study, Land, 7, p. 14.

Lemmen C., van Oosterom, P., Kara, A., Kalogianni, E., Schnaidman, A., Indrajit, A., Alattas, A. (2019): The scope of LADM revision is shaping up, in Proceedings of the 8th International FIG workshop on the Land Administration Domain Model, Kuala Lumpur, Malaysia

Lemmen C., van Oosterom, P., Kalantari, M., Unger, E.M. and De Zeeuw, C., editors (2019): OGC White Paper on Land Administration, Open Geospatial Consortium

Lemmen, C., van Oosterom, P., Kalantari, M., Unger, E.M., Teo, C.H. and De Zeeuw, K. (2017): Further standardisation in land administration', in 2017 World Bank Conference on Land and Poverty, p. 22., The World Bank – Washington DC

Lisec, A., Miran, F. and Šumrada, R. (2007): UML Notation for The Rural Land Transaction Procedure, Geodetski vestnik, 51, p. 12.

Navratil, G. and Frank, A. U. (2004): Processes in a cadastre, Computers, Environment and Urban Systems, 28(5), pp. 471–486. doi: 10.1016/j.compenvurbsys.2003.11.003.

van Oosterom, P., Kara, A., Kalogianni, E., Shnaidman, A., Indrajit, A., Alattas, A. and Lemmen, C. (2019): Joint ISO/TC211 and OGC Revision of LADM: Valuation Information, Spatial Planning Information, SDG Land Indicators, Refined Survey Model, Links to BIM, Support of LA Processes, Technical Encodings, and Much More on Their Way!, in Proceedings of the FIG Working Week, Hanoi, Vietnam

Roić, M. (2012): Upravljanje zemljišnim informacijama Katastar. 1st edn. Zagreb, Croatia: Sveučilište u Zagrebu Geodetski fakultet.

Sari, K. W. (2010): The Workflow of Maintenance of Cadastral Data as based on Land Administration Domain Model (LADM) A case study in Indonesia, Master Thesis, Faculty of Geo-information, Science and Earth Observation, University of Twente Enschede, Netherlands

Vranić, S. (2018): Modelling transactional workflow management system over spatial component of cadastral parcels, PhD Thesis, Faculty of Geodesy, University of Zagreb, Croatia

Vučić, N. and Roić, M. (2014): Complaints in the process of maintaining the cadastre, Geodetski List, 68, pp. 143-156

Zevenbergen, J., Frank, A. U. and Stubkjær, E. (2007): Real estate transactions : Procedures, transaction costs and models, IOS Press.

URL1: Joint Information System: https://oss.uredjenazemlja.hr/public/index.jsp , accessed

30.09.2019.

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