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Utilities Data in Land Administration Systems

Grgo DŽELALIJA and Miodrag ROIĆ, Croatia

Key words: 3D Land Administration System, utility network registration, authoritative data, 3D Cadastre

SUMMARY

With growing urbanization and population, management of space and land has become vital part for sustainable growth and development. Additional to urbanization and population growth, industrialization is another factor for rising need for various utilities such as sewage network, water supply, electricity etc. In such conditions, knowing where one can install new underground or overground infrastructure, without destroying existing lines, becomes more and more of a challenge. The need to connect new suburbs to existing infrastructure requires knowledge of availability. Legal issues in relation to utilities are also becoming increasingly important.

Different countries and societies will have various approach to solving certain challenge, same goes for challenge of utility network registration. Some countries register utilities as separate objects with unique cadastral numbers in land administration while others register only easements. Some countries have centralized approach with high government regulations while in other utilities are registered on municipal level or even administered only by private companies.

In this paper different approaches to utility network data management are analyzed. In all countries, utilities data is maintained by their managers sometimes with the help of very sophisticated applications.

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1. INTRODUCTION

Since industrialization and urbanization periods have started, population density increased, as well as the need for various utilities such as sewage, water supply, gas, electricity, communication network and more. With increasing number of various utility cables, pipelines and tunnels, knowing where one can install new underground, underwater or over-ground utility becomes more and more of a challenge. Nowadays, with rapid urban development, population growth and scarcity of space proper administration of land is only more important than ever (Lemmens, 2011).

Land administration is considered to be the process of recording and dissemination of information about ownership, value and use of land and associated resources. Proper land administration system has many benefits for both individual and community, such as security of ownership and tenure, support for land taxation, security for collaterals, reducing land disputes, improve urban planning and infrastructure development etc. (UNECE, 1996).

With introduction of computers and their abilities, during 1990s, land administration is further consolidated as separate discipline. Land administration is considered an operational component of land management paradigm with functions to ensure appropriate management of rights, responsibilities and restrictions in relation to land. Specifically, functions of land administration related to land tenure, use, value and land development, which includes utility and infrastructure planning and development (Williamson et al., 2009).

Every type of society can have different approaches for dealing with challenges. When it comes to utility administration, we have two different approaches, centralized and decentralized. In former communist countries there is authoritative approach with national frameworks and sets of laws regulating utility administration and utility cadastres on national level, while in western countries responsibility for utility administration is on companies that own infrastructure, or in some cases on local authorities (Roić, 2012).

Republics from former Yugoslavia were part of eastern, or authoritative, approach to utility administration. Therefore, those countries passed utility cadastre regulations on national level. Utility cadastre regulations were concerned only about technical data and they are missing framework for legal relations on utilities, such as rights, restrictions and responsibilities. Through years, laws were occasionally renewed and updated, but never fully implemented (Bulatović, 2011).

In most of the world each infrastructure owner had separate and independent utility register, with data necessary for their own operations. In western countries, with rising number of infrastructures, communal infrastructure systems were created by connecting those separate utility registers. Those utility registers were connected either simply through call centers or similar services for data sharing, mostly on municipality level (Roić & Mastelić-Ivić, 1993).

This paper analyzes and reviews various approaches to utility registration around world. Next chapter is a brief retrospection on various research on the topic of utility registration, third chapter analyses FIG's questionnaires conducted on 3D cadastre workshops, concretely questions regarding utility and network registration in land administration systems. While forth chapter reviews general approaches to utility registration in different jurisdictions.

2. RESEARCH ON UTILITY REGISTRATION

Despite utility networks being relatively new phenomenon, their rising numbers represents growing issue. Indeed, insufficient information about location and depth of underground utilities could lead to damage during excavation followed by accidents and financial losses. For instance, US Pipeline and Hazardous Materials Safety Administration reported eight fatalities, 27 injuries and total loss of around 160 million US dollars due to excavation damages from 2017 – 2019 (PHMSA, n.d.). For many years the legal status of utility networks was uncertain, as the rule of vertical access for land ownership applied. In 2003, Dutch Supreme Court ruled that underground lines are immovable and as such registered property (Stoter & van Oosterom, 2006).

Many studies have been conducted on the topic of 3D cadastre and challenges of registering utility networks. In general, it seems that countries have different approach to utility registration. Van Oosterom et al. (2011) presented the survey conducted by FIG joint commission. The purpose of the survey was to show statuses of 3D cadasters in world. In the context of utility registration, it was shown that there are differences regarding registration of utilities between countries, with some countries like Netherlands and Switzerland including utilities in cadastral databases, some dedicating utility maps, and some, like Croatia, having utility registers and some register utility networks only as rights on parcels. It was also shown that different utilities are registered in different countries, with Turkey being an example of country having only high-voltage power lines registered. In another study, Döner et al. (2010) compared physical and legal components of utility registrations in three countries.

The Netherlands, Turkey and Queensland Australia, with three different approaches to utility registration. They showed that registration of utility networks as only rights on cadastral parcel crossing is simply not sufficient enough to easily determine the location of given utility line. In later study, they also distinguished and overviewed three alternatives to register utility networks in cadastre, including linking to the documents with geometry attributes of physical infrastructure, copying geometry attributes of physical infrastructure and referring to external registers of utility networks, respectively. The third alternative showed to be the optimal solution because that way attributes of physical infrastructure would be maintained at their source by utility network owners (Döner, Thompson, et al., 2011). Pouliot et al. (2015) conducted an experiment with end-users of FITNO register, relevant to utility infrastructure registered in Quebec, Canada. It was shown that these end users preferred simple solution with easy access to most important information and a link to essential cadastral information. Additionally, there is a paper based on doctoral dissertation (Mader et al., 2015) dealing with the challenges of linking and compatibility between different registers in Republic of Croatia. Similarly, Lee et al. (2015) suggested 3D Korean LADM country profile which could allow registration of 3D objects such as utility networks and buildings and ensure compatibility between cadastre and other registers. Another doctoral dissertation (Vučić, 2015) further confirmed the shortcomings of a 2D cadastre model for representation of utility networks and buildings, and once again proposed the 3D model for gradual transition from 2D to 3D cadastre. Yan et al. (2018) proposes initial version of 3D data model of utility networks based on LADM and data acquired from ground penetrating radar (GPR). In Republic of Serbia, researchers have proposed extension for utility networks of their country profile, based data from GPR and LIDAR (Radulović et al., 2019).

One of the main roles of cadastre is to keep record of rights, restrictions and responsibilities on land parcels, such as right of ownership or easement. Utility networks physically intersect land parcels and with that converge with rights on them. For that reason, it would be logical to keep record of utilities in public register so that it can be accessed by all concerned parties. Keeping record of utility networks in a register together with land parcels would be easier and more consistent in a full 3D cadastre. However, since many registers do not have 3D properties, it would be more practical to register utility networks and land parcels separately but with unambiguous link between them (Pouliot & Girard, 2016).

Döner et al. (2010) analyzed and showed that certain implementation of 4D cadastre is possible from legal, technical and organizational perspective. They considered three alternatives, creating a link between parcels and information on utilities, copying complete geometry of utilities into cadastre and finally, creating legal space in cadastre with references to the geometry of physical utilities in external registers. With case study on data from Municipality of Rotterdam the conclusions were that third alternative would be the best solution.

3. QUESTIONNAIRES ON UTILITY REGISTRATION

Several questionnaires were conducted by the FIG joint commission during 3D Cadastre workshops on the topic of status of 3D Cadastres in participating jurisdictions where a special chapter was on registration of utility networks. First questionnaire was conducted in 2010 and was completed by 36 jurisdictions (van Oosterom et al., 2011). Second questionnaire was conducted in 2014 and was completed by 31 jurisdictions (van Oosterom et al., 2014). Finally, third questionnaire was conducted in 2018 (Shnaidman et al., 2019). In 2010 survey, questions about infrastructure or utility networks were whether jurisdictions register networks as an entity in the land administration, can the network structure be traced in the database, does the jurisdiction have private networks, are private networks registered as 3D property parcels, is the text of relevant laws or regulations available in original language, is the text of those laws available in English, do jurisdictions have example descriptions of typical 3D parcels for networks, how do they deal with intersecting networks or vertically parallel networks if the network object breaks at the surface parcel, and whether they have any other geometric issues related to the registration of networks. In 2014 and 2018 questionnaire, second question was extended with three more sub-questions: whether jurisdictions can view network structure graphically in their land administration, are networks registered by means of a cadastral identifier and are rights, restrictions and responsibilities (RRRs), and parties attached to those network objects.

Results from those FIG's questionnaires were analyzed, specifically answers to aforementioned questions about infrastructure and utility networks. For each participating jurisdiction last questionnaire was taken into consideration. In total, 46 jurisdictions participated, with 36 administrative units having taken last questionnaire in 2018, four jurisdictions in 2014 and eight more jurisdictions back in 2010.

First question was whether networks are registered as entity in land administration (Figure 1). 16 jurisdictions answered that they do not register networks as an entity in land administration, 14 jurisdictions answered that they do register networks as entities in land administration with additional two countries, Argentina and Costa Rica, stated that they register networks as entities in land administration only in some cases. Former Yugoslav countries, Croatia, Serbia and Slovenia have separate utility cadastre for registering networks. Additionally, 11 jurisdictions answered that they only register easements or tunnel spaces of networks. In conclusion, 41% of questioned jurisdictions at least in some cases registers utility networks in their land administration systems. Easements or tunnel spaces of utility networks are registered in 24% of jurisdictions, while 35% jurisdictions do not register utility networks in any form in their LAS.

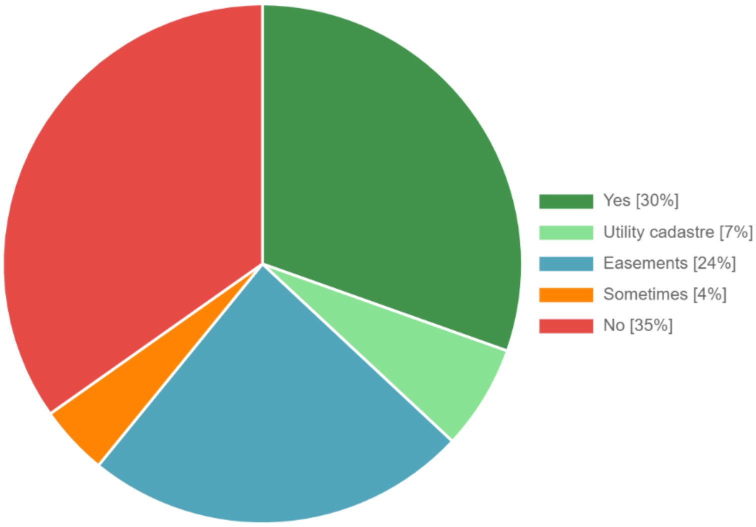

Figure 1. Answers to question 2.1 Do you register networks as an entity in the land administration?

Out of the 19 jurisdictions that at least in some cases register networks as entities in land administration, seven of them can view network graphically in the land administration, can trace network structure in database, have networks registered by means of cadastral identifier and have rights, responsibilities and restrictions, as well as parties attached to concerned network objects (Figure 2). Three countries have three out of those four questions answered with yes or in some cases, with Trinidad and Tobago not having RRRs and parties attached to network objects, and Poland and Argentina not registering networks by means of cadastral identifier. Additionally, in some Swiss cantons network can be viewed graphically in LA and network structure can be traced in database, Scotland can view networks graphically in LA and registers networks by means of cadastral identifier. Two more countries have one question answered with yes, Slovenia can only trace network structure in database while Croatia has only RRRs and parties attached to network objects. Finally, at least in some cases 69% of jurisdictions can view network graphically in the land administration, 74% can trace network structure in the database, 47% have networks registered by means of cadastral identifier, while 53% have RRRs and parties attached to network objects.

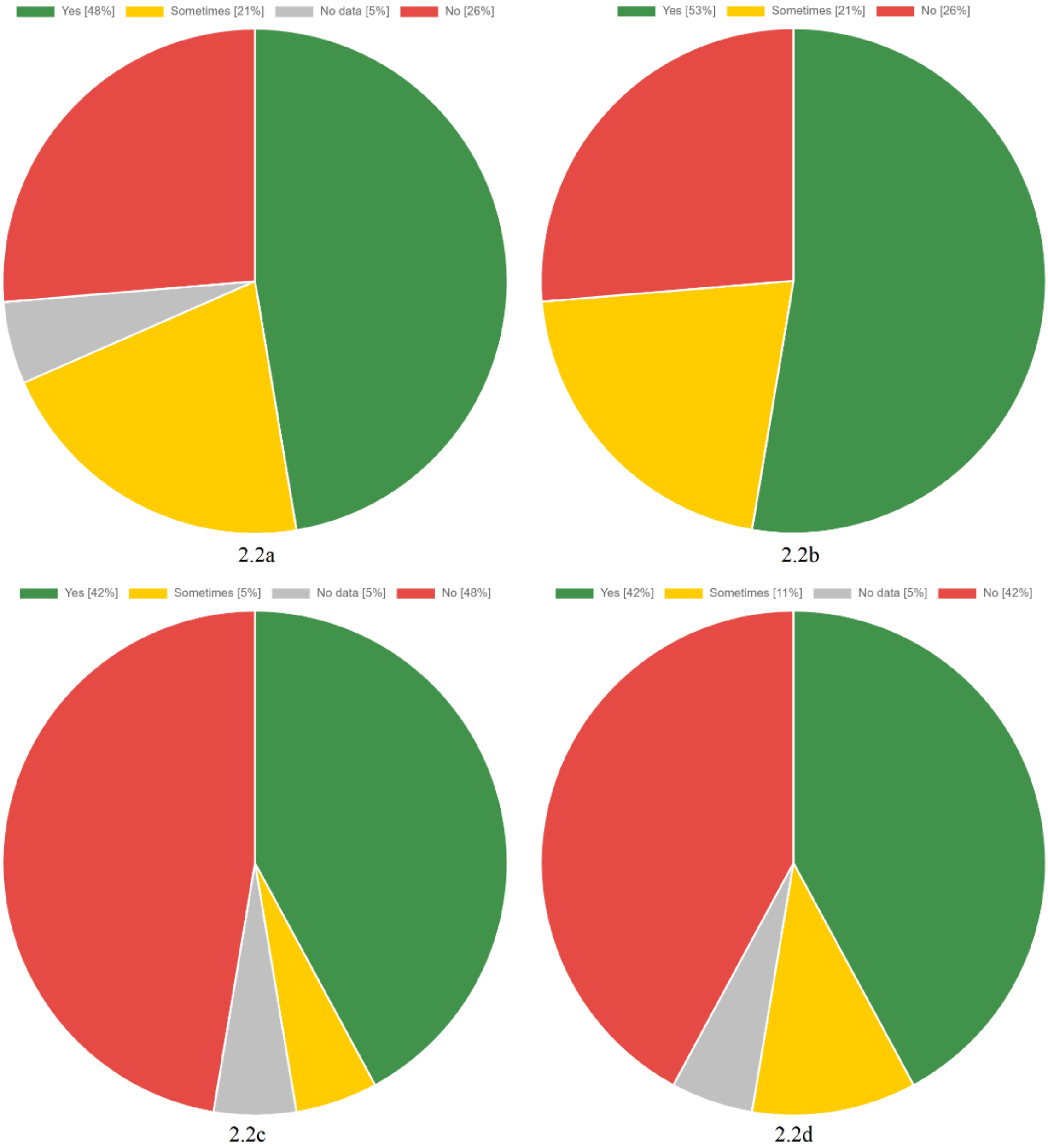

Figure 2. Answers to questions 2.2a Can the network structure be viewed graphically in the land administration?, 2.2b Can the network structure be traced in the database?, 2.2c Are networks registered by means of a cadastral identifier? and 2.2d Are RRRs and parties attached to these network objects? from jurisdictions that register networks as entities in land administration.

Out of the 11 jurisdictions that only register easements or tunnel space of networks in land administration, only Cyprus and Kenya can view easement structure graphically in land administration, can trace structure in database, do register easement objects by means of a cadastral identifier and have RRRs and parties attached to those easement objects. Australian state Victoria doesn't have RRRs and parties attached to easement objects but fulfils other three out of four questioned capabilities. Turkey, New Zealand and Finland have two out of the four questions answered with yes, while Greece has only RRRs and parties attached to easement objects. Additionally, Kazakhstan and Russia had their last questionnaire back in 2010, so they had only question whether network structure can be traced in database included in their questionnaire, which they answered with yes (Figure 3). Results are somewhat lower with jurisdictions that register only easements in LAS, with 46% of jurisdictions can view network graphically in the land administration, 55% can at least in some cases trace network structure in the database, 46% have networks registered by means of cadastral identifier, while 36% have RRRs and parties attached to network objects.

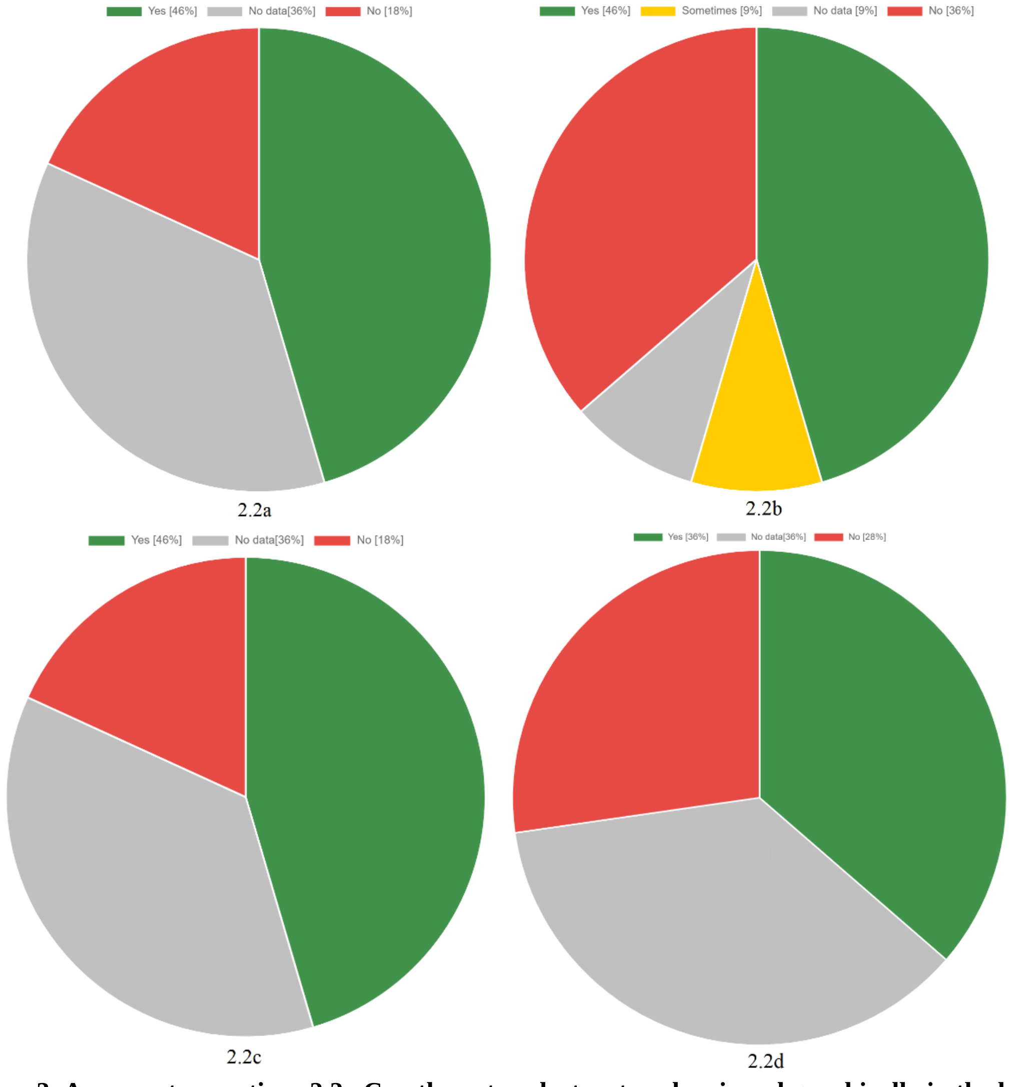

Figure 3. Answers to questions 2.2a Can the network structure be viewed graphically in the land administration?, 2.2b Can the network structure be traced in the database?, 2.2c Are networks registered by means of a cadastral identifier? and 2.2d Are RRRs and parties attached to these network objects? from jurisdictions that register easements of networks in land administration.

When it comes to private networks, 29 questioned jurisdictions, or 63% of them have private networks. Out of those 29 jurisdictions, only six of them register private networks as 3D property parcels, while Croatia registers them sporadically as charges in Land book (Figure 4).

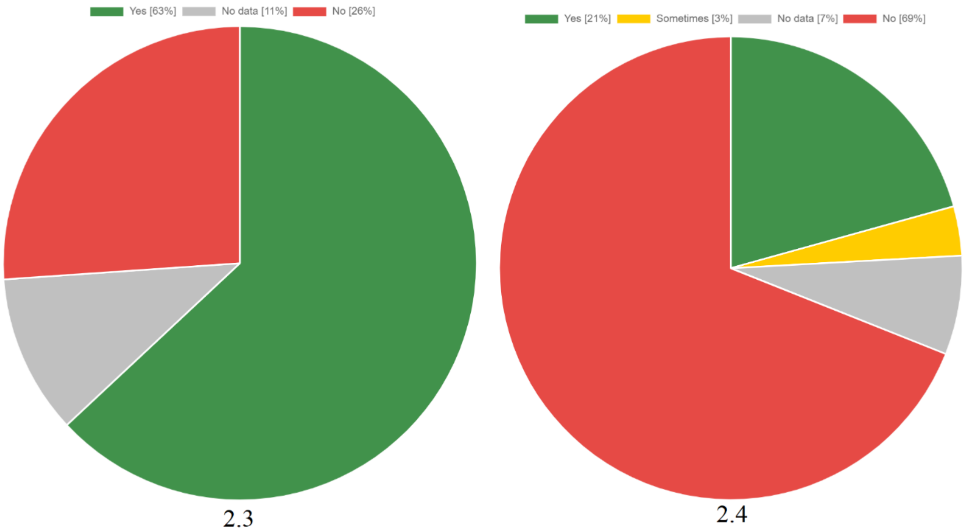

Figure 4. Answers to questions: 2.3 Does the jurisdiction have private networks, and 2.4 Are private networks registered as 3D property parcels?

About half of questioned jurisdictions, or 26 of them, have texts of relevant laws and regulations available in their original language. Additionally, 13 of them have laws available in English, while Switzerland and Greece have few of the relevant laws translated to English as well.
Out of 46 total jurisdictions, only 26% stated that they have example descriptions of typical 3D parcels for utility networks, mostly prototypes.

When it comes to challenges of dealing with intersecting or vertically parallel network legal objects if they break at the surface parcel, most jurisdictions state that they treat networks as continuous and independent objects, usually registered separately. Some jurisdictions show networks and their overlaps in 2D with possibilities of manual checks. As for geometric issues related to the registration of networks most jurisdictions that answered the question state that networks are registered as 3D lines, while The Netherlands and Greece stated as an issue that complete geometry of networks is not registered in cadastral system.

Although utilities registration is very diverse, two general approaches can be distinguished. These would be national utility cadastres and other approaches in which a small part of the data on utilities is registered in the existing registers, the companies are the ones that manage most of the data.

4. GENERAL APPROACHES TO UTILITY REGISTRATION

Pipelines and cables of various utility networks, such as sewage, power supply, heat supply, water supply and electronic-communication networks, just to name the few, are crucial infrastructure of any modern city. And as such, administrating utility networks has always been a challenge, due to various issues like insufficient documents and fast industrialization (Du et al., 2006). There are several ways to classify utility registrations, for example (Stoter & van Oosterom, 2006):

- by degree of responsibility, with complete state mandate or shared public and private responsibility
- by location and jurisdiction, with centralized or decentralized approach.

Considered that there are no national regulations for utility registrations in western world, either local governments, or sometimes even only utility owners, are responsible for updating records, with call centers providing the data. In contrast to that, in former socialist countries, such as former Eastern Bloc countries, utility registration is defined by national laws and regulations and usually kept by state (Stoter & van Oosterom, 2006).

4.1 National Utility Cadastres

Approach of national utility cadastres is mainly driven by idea that data about infrastructure should be authoritative. Authoritative data is considered to be most current and accurate, that data can also be verified and certified by authority (FGDC, 2009).

Among the members of EuroGeographics poll and workshop were conducted on the topic of authoritative data. Conclusions showed that countries consider that public organizations and governments should have central role in authoritative data but also showed that they have different viewpoint on which data should be authoritative (Crompvoets et al., 2019). On the other hand, spatial data available in Land administration systems should be accurate, assured and authoritative, or in other words it should be highly accurate, with high integrity and guaranteed by government (Williamson et al., 2012).

In the second half of the 20th century, questions regarding measuring and managing data of public utility infrastructure began to be raised in the territory of former SFR of Yugoslavia. At the 1967 consulting session in Split, present day Croatia, on the topic of surveying and recording of underground utility installations and facilities, some important conclusions were reached. Two years later, they served as the basis of the Rulebook on Methods and Mode of Operation in Surveying of Underground Installations and Objects (Pacadi et al., 2013).

Through next decades, numerous laws and rulebooks concerning utility registration have been passed in Yugoslavia, and subsequently in Croatia. Those laws and rulebooks proscribed and changed what utilities should be registered in utility cadastre, what data that should be kept in utility cadastre, as well as who has the jurisdiction over utility cadastre. However, to this day, no order and systematic management of data on public utility infrastructure have been introduced and only piles of elaborates are accumulating in cadastral offices without further processing into utility cadastre (Blagonić, 2012).

As in other former eastern bloc countries, in Slovenia registration of public infrastructure is regulated by the law. Furthermore, the Surveying and Mapping Authority of the Republic of Slovenia provided the way in which public infrastructure will be administered and maintained.

Organizing model is divided into three levels (Bitenc et al., 2008):

- The Consolidated Cadastre of Public Infrastructure, which includes only basic information about infrastructure, and is managed by the Surveying and Mapping Authority of the Republic of Slovenia (state level).
- Cadastre of Public Infrastructure, which is managed by local municipalities.
- Operative cadastre managed by infrastructure owners.

Excavators do not have to seek for approval for digging, but in case of changes in their infrastructure, they are obligated by law to forward data about new or changed infrastructure to cadastre of public infrastructure and further in consolidated cadastre of public infrastructure. Public infrastructure included in infrastructure cadastre are traffic infrastructure, energy infrastructure, public utilities, electrical communication networks and others (Šarlah, 2010).

4.2 Other approaches to registration?

Western countries went with different approach and let infrastructure owners to keep their own utility databases. With only intermediating through the distribution of the data. Like most eastern countries, there are state level regulations for administrating and maintenance of public infrastructure also in China. There, National Bureau of Construction provides policies and regulations, and data about public infrastructure is handed to the National or Urban Construction Archive. Owner must send the excavation request to the Municipal Bureau of Urban Planning (MBUP) and to the Municipal Administration Commission (MAC) for the approval. Both MBUP and MAC check the files from National or Urban Construction Archive and determine if excavation is feasible. After MBUP and MAC approved the request, excavator sends those two admissions and implementing report to Municipal Bureau of Construction, which finally gives the construction license and guidelines for excavation. During the construction of infrastructure, surveying is done, and data are then stored in Urban Construction Archive. Public infrastructure includes energy infrastructure, public utilities and electrical communication networks (Bitenc et al., 2008).

On the other hand, Sweden belongs to the western type of infrastructure administration, where there are no regulations for administration and maintenance of public infrastructure, and infrastructure is not registered on national level. Infrastructure owners are not even obligated to manage data end keep record about their own infrastructure. Since it proved useful and money saving for excavators to have an easy access to data public infrastructure, some municipalities have started initiatives to collect data about public infrastructure in one place, so anyone concerned can access it easily. Those municipalities organized services, like Grav in Gavle, to which excavator can send a request for digging. The request is then sent to all registered infrastructure owners, who enter restrictions and necessary information for digging next. Services are optional, and infrastructure owners are free to collect needed information in any other way (Bitenc et al., 2008).

In United States of America, there is a service named Call Before You Dig, with special call center for each state. In all states it is mandatory to contact the call center few days before digging. Request is then sent to all concerned infrastructure owners who send locators to mark the pipelines in requested area (Before You Dig | Call811, n.d.).

Similarly, Canada has toll-free one-call number for each province. After contacting call center, call operators will help locate pipelines within two to three days. Both excavators and pipeline operators are responsible for protecting workers, public and environment. Excavators are responsible for contacting call centers and identifying locations of pipelines before digging, while pipeline operators are responsible to construct pipelines in accordance with regulations as well as responding to requests for identifying pipeline locations (PREVENTING PIPELINE DAMAGE Canadian Energy Pipeline Association Our Challenge, n.d.).
In Republic of Turkey there is no organized registration on national level, but it is regulated by law to establish AYKOME if municipality has more than 500.000 people. AYKOME keeps records, provides information and determines when and if the excavation can take place (Döner, Demir, et al., 2011).

Finally, in The Netherlands, private institute, Cable and Pipeline Information Centre (KLIC) was established in 1980s. Excavator could, but was not obligated to, contact KLIC, who would then forward the request to concerned infrastructure owners in area. Infrastructure owners would send back their maps and information about infrastructure in requested area. In 2008, Netherlands' parliament passed an act which transferred KLIC service to the Netherlands' Cadastre and enforced infrastructure owners to participate in the system (Stoter & van Oosterom, 2006).

5. CONCLUSION

From previous research on the topic of utility registration or 3D cadastre, as well as from questionnaires conducted on FIG-s 3D cadastre workshops, we could observe that there are different situations of utility registration around the world. With approaches varying from some jurisdictions having complete governmental responsibility on utility registration, to some jurisdictions having few to no regulations concerning utility registration. In some jurisdictions all utilities are owned by state or state-owned companies, while in others we have private owned utilities.

In most jurisdictions some of main incentives for utility registration are safety and accident prevention. When it comes to legal aspect of utilities, their impact on rights on cadastral parcels that they cross is recognized, usually only in the form of easements. Contrarily, their own legal status and value is rarely recognized. They are still rarely registered as property parcels.

Some noticed shortcomings of the questionnaire were unanswered questions and differences in interpretation of given questions. Some of those shortcomings could be reduced by defining some questions in more detail or by giving precise examples. Also, for the further research, some additional questions could be added to questionnaire for the purpose of showing efficiency among general approaches to utility network registration.

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BIOGRAPHICAL NOTES

Grgo Dželalija graduated with master's degree in Geodesy from the University of Zagreb, Faculty of Geodesy in 2013. Since 2014. is at Ericsson Nikola Tesla d.d. as senior software developer. Projects he has been working on include Joint Information System for Cadastre and Land Registry of Republic of Croatia, katastar.hr platform, System for Infrastructure Cadastre of Republic of Croatia and other.

Miodrag Roić graduated with a degree Geodesy from the University of Zagreb, Faculty of Geodesy. In 1994. he received a PhD from the Technical University Vienna. Since 1996, he has been a professor at the University of Zagreb, Faculty of Geodesy. He was Dean of the Faculty during the period spanning 2011-2015. The topics in which he specialises are Cadastre, Land Administration Systems, Engineering Geodesy and Geoinformatics. He is a corresponding member of the German Geodetic Commission (DGK) and many other national and international scientific and professional institutions.

CONTACTS

Grgo Dželalija
Ericsson Nikola Tesla d.d.
Krapinska 45, HR-10000 Zagreb
CROATIA
Phone: + 385 (1) 365 3814
E-mail: grgo.dzelalija@ericsson.com

Prof. Miodrag Roić
University of Zagreb, Faculty of Geodesy
Kačićeva 26
HR-10000 Zagreb
CROATIA
Tel. + 385 (1) 4639 229
Email: mroic@geof.hr
Web site: http://www2.geof.unizg.hr/~mroic