Towards Enhanced Evaluation and Comparison of Mature Cadastral Systems

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SUMMARY

A functional cadastral system is widely recognized as a key element of a land administration system capable of supporting economic, social, and ecological sustainability and welfare. Cadastral systems are unique and country-specific, but at the same time share many similar qualities and serve the same purpose of delivering trusted information of land related interests. Learning from the qualities and development stages and trajectories of other countries' cadastral systems is vital from the perspective of developing the current systems. However, to meaningfully describe and compare cadastral systems of different countries and their strengths and weaknesses, we need a shared conceptual language to support the analysis and discussion. So far, the literature has largely focused on defining the basic requirements a cadastral system has to fill to be considered a modern, developed cadastral system, or what can be called a mature cadastral system. Beyond these conditions, there is relatively little research on how mature cadastral systems should be evaluated and compared to find meaningful differences between different systems. Themes such as 3D land administration, advanced administration of rights, restrictions, and responsibilities (RRRs), and the role of cadastral system in wider society, for example, are currently popular topics of discussion that should be reflected in how cadastral systems are evaluated. This paper aims to fill this gap and advance understanding of the key elements of mature cadastral systems, to allow a more meaningful comparison of different systems. To that end, we review the extant literature and propose a set of themes that should be considered when comparing mature cadastral systems. Eight relevant themes were identified that can be used to structure and assess the information contents and operational environments of mature cadastral systems. Themes range from the data contents of the systems and their interoperability with adjacent systems to business ecosystems and the data distribution mechanisms. The results indicate a wide variety of topics being relevant for the evaluation of mature cadastral systems and provide a good starting point for further development of a standardized method to describe and compare mature cadastral systems.

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1. INTRODUCTION

The importance of a functional cadastral system for a land administration system capable of supporting economic, social, and ecological sustainability and welfare is widely recognized. To efficiently develop these systems, a shared methodology for comparison and evaluation is needed. There have been previous efforts to do so, a notable example being the Cadastral Template Project, developed by Steudler et al. (2004). However, most previous frameworks for comparison have either been developed to fit all cadastral systems, regardless of state of development, or to specifically evaluate emerging cadastral systems. Less research has been conducted on frameworks capable of recognizing meaningful differences between mature cadastral systems. By mature cadastral system we refer to systems with long traditions and established practices to record information on real properties and related interests.

This paper addresses this gap by proposing a set of themes to consider when evaluating and/or comparing mature cadastral systems. The themes are based on a hermeneutic literature review, with the goal to recognize parts of the system where most development has happened in recent years, and thus where most differences between mature systems are likely to occur. These themes were then separated into two categories to further clarify how different factors contribute to how the cadastral system functions. We recognized in total eight themes. Five of them are focused on Five of the eight themes are focused on the information contents of cadastral systems, three are focused on the operational environments.

2. PROPOSED THEMES FOR EVALUATION AND COMPARISON

In this section, we propose a set of themes and describe what kinds of issues should be examined to understand each theme. To effectively understand how each cadastral system works, we need to understand how the system itself is built, and how it interacts with the wider society around it. In this paper, the term cadastral system is understood in a broad sense, by which we mean that the term also includes the organizations, actors, procedures and regulations that contribute to the recording of information on real properties and related interests. Therefore, we propose that it is important first of all to distinguish between the characteristics related to the information contents of a cadastral system, and the characteristics related to the broader operational environment of a cadastral system. The themes for evaluation and comparison are organized under these two dimensions. Themes regarding information contents (Section 2.1) aim to describe what kind of information is stored in the system and how up-to-date and high quality is the data. Themes related to the operational

environment (Section 2.2) on the other hand help to assess, for example, what kind of role does the cadastral system have in the society, and to what extent the system is able to respond to needs and requirements stemming from the society.

2.1. Information contents

2.1.1. 3D Land administration

The implementation and development of registration of three-dimensional real property has been a topic of much discussion in recent years. Increasing urbanization has highlighted the need for more precise registration of real property in cases such as tunnels, bridges, and underground real estate (Stoter et al 2013). In cases where multiple properties overlap the same 2D-space, more accurate means of registration are needed. Döner et al (2010) argue that 3D-cadastre is also beneficial for safety, as underground structures and infrastructure are accounted for. For these reasons, when evaluating mature cadastral systems, it is relevant to ask whether there is any possibility of three-dimensional registration, and if there is, how is the registration executed.

According to Aien et al. (2011), the development of a functional 3D cadastre requires the development of legislation, technology, and the institutional environment of the cadastre. To properly understand why differences in development of 3D registration occur, the systems should be examined thoroughly. For this reason, it is sensible to include 3D-registration as a part of extensive, holistic examination of cadastral systems.

2.1.2. 4D Land administration

In 4D-land administration, a temporal dimension is added into consideration. According to Döner et al (2010), from a four-dimensional cadastre past boundaries, rights, restrictions, responsibilities, and objects such as utility networks should be visible. Krigsholm et al (2018) also noted, that temporal aspect of cadastral information is especially of importance to the processes of land valuation, land use planning and environmental monitoring.

In addition to better understanding how land use has changed over time, temporal aspects are interesting when considering the quality and relevance of data in cadastral systems. How the system is equipped to process temporary or time-limited rights, restrictions, and responsibilities can contribute to irrelevant or outdated data accumulating in the cadastral system.

2.1.3. Rights, restrictions, and responsibilities (RRR)

According to Williamson et al (2010), a modern cadastre capable of supporting sustainable development should include a wide variety of rights, restrictions, and responsibilities (RRR). More specifically, Bennet et al (2008) argues, that for RRR to serve their purpose, they should be kept up to date, and removed from the cadastre when no longer relevant or useful. These statements support the notion that evaluating contents of mature cadastral systems from RRR point of view is necessary to understand how the cadastre is utilized as a land administration tool.

Bennet (2007) proposes a way of classifying rights, restrictions, and responsibilities based on five basic properties of RRR: the reason for creation of the RRR, function it restricts or allows, area of effect, duration, and people affected by the RRR. This classification is a helpful tool for understanding what kind of rights, restrictions, and responsibilities are registered in cadastral systems and what are not.

2.1.4. Information content related to wider society

Cadastral systems are used for multiple purposes in modern societies. The role of cadastral system in taxation of land is widely recognized, as noted by, for example, Williamson et al. (2010) and Bandeira et al. (2010), and many cadastral systems have originally been founded for fiscal reasons. Some cadastral systems contain information on land values, some are used mainly to extract information on land areas and ownership. Understanding the level of integration between cadastral and taxation systems enables insight into the societal role of a cadastral system.

Land use planning is one of the key areas of land administration (Williamson 2010), making the connection between land use planning systems and the cadastral system an interesting and relevant area of evaluation. In addition, according to Krigsholm et al. (2018), access to up-to-date information about land use planning is also beneficial to taxation and provision of digital services. Other relevant information content related to cadastral systems and wider society are the locations of infrastructure such as utility networks, as Döner et al. (2010) suggested.

2.1.5. Up-to-dateness and reliability

Ability to reliably support different societal functions, such as taxation and sustainability efforts, is often mentioned as a core function of a modern cadastre, however, the amount and variety of information within a cadastral system becomes irrelevant, if the information cannot be trusted, making reliability an important theme for comprehensive evaluation. Krigsholm et al. (2018) note that especially tightened banking regulations have caused the demand for reliable and up-to-date information to increase, and that the reliability and up-to-dateness of the data are key needs for users of cadastral data. Similarly, Bennet et al. (2011) highlight the

need for quality data to ensure functional real estate markets. According to Bandeira et al. (2010), ensuring the trustworthiness of cadastral information is a key requirement for a mature cadastral system. It is also relevant to consider who is responsible and liable to compensate if inaccurate cadastral information leads to economic loss.

2.2. Operational environments

2.2.1. Institutional environment

To fully comprehend the institutional environment of each cadastral system, the roles and possible collaboration of public and private sector should be examined carefully. According to Williamson (2001), the most efficient way of organizing the institutional structure of land administration is to keep all functions, such as upkeeping the cadastre, mapping and surveying, within the same organization. However, later Williamson together with Bennet and Wallace stated that reforming institutional structures in this way might not be cost efficient (Bennet et al 2011), making it evident that multiple factors contribute into a successful institutional environment and thus, a single solution might not fit all systems.

Another point of view to approach cadastral systems is their funding structures. Are they self-sufficient due to fees collected from users, as Kaufmann and Steudler (1998) argued they should be, or does the system receive governmental funding? The funding structure is a relevant concern, as it ties back to questions about the development of the systems, and to the distribution of open data and its effects on the financial viability of cadastral systems.

2.2.2. Interoperability

Closely connected to the institutional environment of cadastral systems is interoperability, how the cadastral system interacts with different registers and data sources surrounding it. To allow more complex problems to be solved with the help of cadastral data, the system must be compatible with other key registers. According to de Zeeuw and Salzmann (2011), this capability for problem solving is an increasingly important feature for the users of cadastral data. Krigsholm et al. (2018) also note that interoperability between public registers is necessary to fulfill the needs of the users.

2.2.3. Users and distribution of cadastral data

Todorovski and Lemmen (2007) divide the users of cadastral systems to internal and external users, external users consisting of both private and public users uninvolved with upholding the cadastral system. Understanding the accessibility of cadastral data for these external users is vital to understanding value cadastral data is able to create in the society. Different methods of data distribution, availability and cost of access should be evaluated.

As de Zeeuw and Salzmann (2011) noted, the cadastral system's capability to support problem solving is an increasing need among the users of cadastral data. This also opens opportunities for new services and businesses to arise, that utilize cadastral data to provide increased value for their customers. Digitalization being a major force of change, electronic services especially are an area of interest and possibilities. Krigsholm et al. (2020) observed that digital services are a notable area of development for modern cadastral systems and regarded as important by almost every group of users.

3. DISCUSSION AND CONCLUSIONS

There are multiple points of view that should be considered when evaluating mature cadastral systems. In this paper, we chose to concentrate on developing an extensive set of themes that help to describe mature cadastral systems in their entirety, instead of focusing on an intensive analysis of a single theme. As mature cadastral systems strive to benefit societies on a wider scale, their evaluation should not be limited to their contents, but should also cover their impact on other parts of society. The set of themes this paper proposes allows to describe cadastral systems comprehensively, focusing both on the contents and the environment and interactions of the cadastral system. Compared to prior evaluation frameworks developed for cadastral systems (see Steudler et al 2004), the set of themes proposed here should better reflect the current needs of societies. Themes of interoperability and distribution of data, for example, are increasingly relevant in the information society we live in.

Possible limitations for the use of these themes may arise from their wide definitions. As they are intended to create comparable understanding of all mature cadastral systems, some special characteristics of specific systems might be ignored by them.

To develop the themes for more efficient comparison and evaluation, more specific criteria for each theme should be defined. The themes proposed in this paper are presented on a rather abstract level. Hence to better utilize the themes for evaluating different cadastral systems, a more precise definition for the key aspects of the systems is needed. By expanding the set of themes into a full framework, it could also be used to define each system's characteristics to create comparable profiles of different cadastral systems. This way, the applicability of the framework could also be tested on multiple different types of cadastral systems.

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