AN INTEROPERABILITY TOOLKIT FOR e-LAND ADMINISTRATION

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SUMMARY

Enablement of land administration with Information and Communication Technology (ICT) is heading toward e-Land Administration (e-LA): the transformation of land administration through the use of ICT. Existing initiatives include providing land information online, electronic conveyancing, digital lodgement of survey plans, and online access to survey plan information. Thus far, implementation of these initiatives is isolated in their specific subsystems without reference to the broader land administration system or its core policy function of supporting sustainable development.

One solution to isolation is to develop effective communication among the different land administration subsystems by harmonising data and functionalities through interoperability, so they are capable of being used by all subsystems. There are various aspects for interoperability in an e-land administration system: semantic, legal, inter-community and technical. The aspects need a range of tools to facilitate the interoperability issues in e-land administration. The key to interoperability is data modelling which both recognizes and reengineers existing business processes. Modelling allows every single process in land administration to influence the cadastral data model and vice versa. This paper describes the need of interoperability in e-land administration and importance of cadastral data modelling in data management as well as coordination among subsystems in an e-land administration.

1. INTRODUCTION

Land administration systems evolved from a focus on core functions of regulating land and property development, land use controls, land taxation and disputes (Dale & McLaughlin, 1999) to an integrated land management paradigm designed to support sustainable development (Enemark et al., 2005).

In the new land management paradigm, the land development is added to the core functions of land administration: land mapping, land registration, and land valuation. These agencies are encouraged to take up new opportunities for better management of diverse internal approaches and overall delivery of land administration system policy. Also the unique institutional, economic, legal and technical settings of each country or jurisdiction are recognized.
In many countries, the diversity of agencies leads land administration to diversification of services and functions to manage real property. For example, the land registry places emphasis on the holding and the registration of private rights, restrictions and responsibilities on property parcels. At the same time, the land development subsystem is concerned with use restrictions imposed through zoning mechanisms. Taxation and valuation focus on the economic function of the real property.

Although these processes seem to be independent, each is generally applied to the real estate parcels and moreover they, and other systems such as utility supply, can be all related together. For example, local governments supply property details to the extent of their local government areas; the water utilities prepare proposed plans of their area of interest. On ground identification is provided by surveyors through development plans which are added to the property data set. The land taxation office requires the change of property use as well as the property owner to calculate the revenue and tax for specific purposes. Ideally, these activities require exchange of information among the subsystems; in the digital world, they should not duplicate information but should use each others’ data sets as a resource and as an input for their own database (Figure 1).

Each subsystem has specific functions and services. These specific functions or services directly impact on their databases. For example, a register of title or deeds normally contains a record of the attributes associated with each parcel: its owner, the interests held and description of land. In an open registry, functions and services include providing this information to the public. In valuation and taxation systems, several techniques for estimating the value of the property may be used; each technique serves different purposes and makes different assumptions. For land use planning and land development control, the organization needs various datasets as well as various functionalities for analysis and decision making. The unique perspective of each agency causes it to implement specific functionalities to deliver its services and to develop different data structures.

To meet government needs for up-to-date, complete and comprehensive information, land administration systems intend to treat the data and services of each of the subsystems holistically, by utilizing ICT.

ICT is being heavily utilized by land administration subsystems. Although it provides opportunities for better service delivery and customer satisfaction and reduction in operating costs, establishment of e-Land Administration has to date not been fully realized and is often problematic. This problem rises from the lack of flexibility and incompatibility of subsystems’ services. They most often encounter problems with data coming from different sources, being highly dispersal, and lacking conformity to standards. The difficulties increase, when the data is coupled with complicated technologies and bureaucratic management. Interoperability is one idea offered to overcome this problem.

2. INTEROPERABILITY

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Interoperability in information systems is the ability of different types of computers, networks, operating systems, and applications to work together effectively, without prior communication, in order to exchange information in a useful and meaningful manner (Inproteo, 2005). Interoperability is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units (Rawat, 2003).

In the domain of spatial information interoperability is the cooperation, the compatibility of an information system to run, manipulate, exchange and share the data of different organizations related to spatial information on, above, and below the Earth’s surface; for any kind of application to serve the society over networks (Rawat, 2003). The idea was then developed for businesses and organizations as well as public administrations to improve collaboration and productivity in general, increase flexibility, enhance services efficiency and add to productivity while simultaneously reducing the costs.

The complexity of land administration systems raises issues not only related to technical aspects of the subsystems but also related to the semantics, legal and inter-community aspects which need to be addressed to achieve interoperable e-Land Administration system. Interoperability in e-Land Administration facilitates the ability to link land administration subsystems cost effectively to share the resources, find the data, functions and processing to serve the public.

3. e-LAND ADMINISTRATION INTEROPERABILITY FRAMEWORK

As mentioned, the complexity of e-Land Administration is the main reason for installing interoperability in it to perform effective services to users. Interoperability covers a wide scope which is undesirable. To make the concept workable it is classified as the ability to drill down through various levels of data. Interoperability in e-Land Administration framework can be considered in four aspects: semantic, legal, inter-community and technical (Figure 2).

**Semantic interoperability:** The land concept may be viewed from different perspectives. The ordinary citizen and physical planner may think of it as actual space in which people live and work; the lawyer may think of it as real property rights, while the economist and accountant may see it as economic commodities. Others may see it as a part of nationhood and cultural heritage (United Nations, 2004). From whatever perspective, land administration as information infrastructure that supports land management should include harmonization in the terms of terminology. Furthermore, the lack of semantic interoperability and heterogeneity occurs where there is a disagreement about the meaning, interpretation, or intended use of the same or related data in various domains (Tuladhar et al., 2005). In other words, these different, but related domains need to be harmonized, particularly because even within one domain, such as the cadastral domain, disagreement on the use of concepts and their semantics occurs. It will be even more difficult when we are dealing with other domains like a land registry, land taxation and others. A single standard might not be possible but a core standard based on common concepts should be achievable; common concepts allow talking across boundaries (Lemmen et al., 2005). Semantic interoperability represents harmonized terminology and interpretation of concepts.

**Legal interoperability:** Mainly land administration organizations have internal process and workflow management solutions, but policies and supporting guidelines are needed to ensure land management/administration is effective across the range of organizations. For example, to ensure the optimum use of space and to enable the land market to operate efficiently and effectively there must be a framework of land and property laws (United Nations, 2004) which facilitates legal interoperability among the organizations. Another example is the uniform description of the cadastral domain which allows cost-efficient construction of data transfer and data interchange systems between different parts (Paasch, 2004).

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Furthermore at the international comparative level, most property registration infrastructures remain mainly regional/local, while banking infrastructures are global. The real estate market has, at least for a subset of society, become global as well (Roux, 2004).

Legal interoperability will develop directives, rules, parameters and instructions for managing business work flow considering information and communication incorporation in the business of land administration.

**Inter-community interoperability:** Inter-community interoperability is concerned with the coordination and alignment of business process and information architectures that span people, private partnership and public sector together. Intercommunity interoperability leads land administration systems to be built on a basis covering the whole sector for land administration, so users should not have to turn to a number of systems to obtain a complete picture (Ljunggren, 2004).

The World Bank report on comparative study of land administration systems realized lack of national interoperability in various study areas. For example multiple agencies with overlapping land administration roles and responsibilities, each supported by empowering legislation, is a critical issue in some countries in Asia (WorldBank, 2003). The same situation pervading almost every Latin American country is separation, at the information and institutional levels, between the property registry and the cadastre (WorldBank, 2003). Coordination is also a critical issue in Africa where there are major problems surrounding the flow of spatial information for land administration purposes both within government, between departments at national level, between national and lower level tiers of government, and between government and the private sector and users (WorldBank, 2003).

Inter-community interoperability includes consideration of providing a unique portal to perform various tasks and applications in land administration. Simple and single portal instance is Google.com which presents a very good example of simplicity to achieve interoperability. The user interface consists of approximately 31 words, a textbox, and two command buttons. This extremely simple interface hides some very complex logic and operations – a concept that we should seek to provide in land administration and real estate management (Roux, 2004).

**Technical interoperability:** The need for technical interoperability should be realised. Many types of heterogeneity are due to technological differences, for example, differences in database, data modelling, hardware system, and software and communication system.

The differences in DBMSs is largely in data models which have direct impacts in data structure, constraints and query languages (Radwan et al., 2005). Also, in order to satisfy the market needs, the data must be reliable and timely accessible to all users. In order to minimise data duplication, data sharing partnership between data producers are coordinated so that there are fewer conflicts about their data standards (Tuladhar et al., 2005). Another example of technical interoperability is the benefit of web access to cadastral information services, which involves the ability to use the functions between any kinds of platform, regardless of programming language, operating system, computer type, etc (Hecht, 2004).

Consideration of technical interoperability includes ensuring an involvement in the continued development of standard communication, exchange, modelling and storage of data information as well as access portals and interoperable web services equipped with user-friendly interfaces.
4. e-LAND ADMINISTRATION INTEROPERABILITY TOOLKIT

The modern e-Land Administration system would include range of processes that should be undertaken on a variety of land information and related data. The examples are establishment of water trading register, natural resource register and aboriginal heritage register which are being added to the classic processes of land administration like the private land registry. Holistic and comprehensive treatment of such an e-Land Administration system requires range of tools to cover the mentioned interoperability levels in e-Land Administration.

The semantic, legal and inter-community issues impact more on administrative and political levels. They are related to arrangement of data sharing and process among the land administration subsystems. The spatial data infrastructure is a tool for meeting the objectives of those interoperability levels (Rajabifard et al., 2005). This can be considered as organizational SDI (Figure 3). The challenge is integration of built environment and natural environment data to support sustainable development objectives.

Implementing technical interoperability is influenced by the lower levels of interoperability and requires a range of tools to cover the scope of the other interoperability levels. In fact technical interoperability tools are instruments for implementation of the idea of interoperable land administration.

A technical interoperability toolkit should offer wide range of facilities to cover the requirements of the other levels. It should provide tool for managing data including modeling, capturing and converting, etc. The toolkit also should provide tools to adapt the organizational structure of the land
administration system in a digital and electronic format. Access and sharing tools facilitate data and information exchange among the subsystems of land administration. After providing data accessibility in a proper electronic architecture, the toolkit should supply the proper models and functionalities for decision making. So the technical interoperability toolkit includes four major tools (Figure 4):

**Data management tool:** Data management tools facilitate and manage the development or intensification land information from multiple distributed sources. Cadastral data that are stored for use in local databases can often be used in external applications once they are published. The data management tool facilitates data description, data modelling, data capture, database design, data catalogue and data conversion and migration as a mean to holding cadastral information in a standard way to be deliverable across multiple servers for access and sharing.

**Enterprise architecture design tool:** Enterprise architecture design tools facilitate and support development of plug-and-play enterprise systems and architectures using a web-based foundation. The Open GIS Consortium (OGC, 2003) believes that applications will be based on compositions of services discovered and marshalled dynamically at runtime (just-in-time integration of services). Service (application) integration becomes the innovation of the next generation of e-business. As businesses move more to web services a set of standards is needed to create service oriented architecture. For example for interoperability with external software, the use of web services standards is one of the approach (Hecht, 2004).

**Access and sharing tool:** Access and sharing tool facilitates the development of a web-based access in a seamless and integrated view. These tools provide recent interoperable sharing techniques, based on international standards like OGC (2003) in realizing simple inter-operability through specification that is considered also in the ISO International Standard. Access may include the order, packaging and delivery, offline or online, of the data (Nebert, 2004). Once cadastral data of interest have been located and evaluated, using the data management and sharing techniques, access to detailed cadastral data is allowed by web services.

![Figure 4: Land Administration Interoperability Toolkit](image)

**Exploitation tool:** Exploitation tool is what the consumers do with the data for their own purposes. Decision support and exploitation tools, especially in land use and land development functions of land administration, facilitate decision-support applications that draw on multiple, distributed cadastral data.
resources. The initial focus of the interoperability is to improve the quality and accessibility of related knowledge, information, and data.

**DISCUSSION**

The paper introduced a range of tools to implement the idea of interoperable e-land administration. Within interoperability toolkit the data modeling tool will play an important role to facilitate interoperability.

The data modelling formulates the proper way of capturing spatial and non-spatial cadastral data. Database design is based on data modelling. Data modelling is a conceptual level of modelling which underpins the design of logical and physical models of the database. The modelling component allows the data catalogue to fit metadata in the proper position whether it is separate or integrated with the other data. Also modelling introduces standards for the exchange and conversion of data among the various services for different organizations (Kalantari et al., 2005).

Furthermore a data model is a basic step toward efficient service delivery, because data are defined in the context of business processes. It allows every single process in land administration subsystems to directly influence the core cadastre model. The modelling process should recognize the business processes to mirror them in the reference cadastral model (Kalantari et al., 2005).

A reference cadastral data model which recognizes all subsystems requirements will facilitate interoperability in e-land administration. It helps data to be exchanged efficiently without missing data in the process of converting a data model into another. Using the reference cadastral data model, two methods can be proposed for data exchange between subsystems.

The first solution is data oriented. It uses the reference to match the data in the central repository. It allows data conversion in a target subsystem or data configuration before sending to another target subsystem. There have been many efforts to facilitate interoperability using open GIS software which allow clients to read various data formats, but the process of converting data from one format to another is usually is followed by data loss. The problems increase when one subsystem wants to add their particular data to the other subsystem database. Furthermore in the huge databases like a cadastral fabric with large amount of attributes linked to it, the process of converting and adding data is time consuming.

A second solution is service oriented. It uses a unique reference cadastral data model for one the fly translation of data. The reference cadastral data model defines the key data elements for linking databases together in order to undertake a process in a particular service. For example the reference cadastral model enables the service to derive full description of a property by on the fly translating and combining land mapping and land registry databases.

**CONCLUSION**

The paper is the result of an ongoing PhD research project which accepted sustainable development as the central driver for modern e-Land Administration. The modern e-Land Administration system includes four major subsystems: Land Mapping, Land Registry, Land Development and Land Valuation. The huge amount of data exchange among the subsystems increases interoperability issues. The paper introduced the aspects of interoperability and offered range of tools to facilitate the data and process interoperability in e-Land Administration systems.

Within the interoperability tools, cadastral data modeling is playing a central role to overcome interoperability issues. The paper introduced two methods for implementing a reference core cadastral
data model for modern land administration system. The next step will be investigation on the advantages and disadvantages of two methods.

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