

Land and Cadastral Information Management : Technology Perspectives

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Author: Pierre le Roux
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Land and Cadastral Information Management Technology Perspectives

1. Abstract

Land and cadastral management systems are being implemented or modernized in different countries and regions, each with its own specific cultural, economic, organizational, technical and political environments and circumstances. It has become clear that each implementation requires a solution to meet the specific prevailing circumstances, requirements, and objectives. Information management, positioning, and communication technology are common components of these implementations.

Technologies, taken for granted in some countries, may not be available to the required extent in others. Or the technologies may not yet be readily supported or accepted in some regions or countries. The resources required for the implementation of sustainable land information management infrastructures differ widely around the world:

- Skill levels
- Expectations
- Availability of logistical and other material resources

This white paper presents perspectives on the impact that technology may have on land and cadastral management. It also reflects on the importance of the often forgotten non-technology issues in land management and land information management. This paper emphasizes the need to ensure that appropriate sustainable technology and solutions are implemented in support of land and cadastral management.

2. Introduction

As inhabitants of planet Earth, we should have a good understanding of the role and value of land in our lives and in the lives of our descendants. There are different views on the role and value of land – views colored by our individual roles and responsibility in the land management process, our relationship with land, and our individual aspirations and goals. These influence our views on the availability, utility, use, and cost of land-related information.

We now live in a society in which we daily experience the impact that information technologies have on our lives. As custodians of land information management systems and the cadastre, we have to consider the impact of technology on the land and cadastral management industry. This quickly leads to debates about technology, politics, public administration and policy, and microeconomics.

These debates very often take place within the confines of the theories, technologies, and practices we were taught and have experienced. We often forget to question whether these theories, technologies, and practices still hold true, given developments and trends in the evolutionary information society in which we live.

The land and cadastral management industry, just as other industries, are characterized by trends and new developments that, either gradually or speedily, produce changes important enough to require strategic response from industry participants. Michael Porter (1980) comments that “industry conditions change because forces are in motion that create incentives or pressures for change.”

Some of the more dominant of these trends and *forces of change*, termed *driving forces*, are further elaborated upon in this white paper. Some of the impacts that current and future technology may have on the land and cadastral management processes and industry are also briefly visited.

3. Dominant Industry Driving Forces

3.1 Regulatory Influences and Government Policy Changes

Changes in government policy and regulations are signifying important changes in industry practices and strategic approaches. The changes in government policy and regulations are driven by factors both internal and external to government.

These drivers for change include:

- The need to generate more non-tax revenue in order to fund required government operations without tax increases
- Process reform and improvement, driven by demand for increased efficiency and speed in handling increasing volumes of transactions
- Public demand for integrated service delivery, and improved front-end customer interfaces and services
- Microeconomic reform
- Advances in technology

Governments in developed countries, countries in transition, and the developing world, are responding to these drivers. In many instances, the response involves re-engineering government or certain governmental functions.

The privatization of selected government services has become one of the most common outcomes of “re-engineered governments.” Land Administration, Cadastral Management, and Land Records Management are more often becoming the target of government services privatization programs – most of which will evolve into new generation “Information Utilities.”

While not all of the functions and responsibilities of a Land Administration, Cadastral Management or Land Records Agency can be privatized or contracted out, the operational information management function of such government agencies usually is one of the functions that can be privatized or contracted out. This partially explains the evolution towards “Information Utilities.”

Banking on the concept that information – especially land information – has become “*a new basic resource that supplements the familiar natural resources of matter and energy*” (Encyclopaedia Britannica), investors in Information Utilities are anticipating real returns on their investments.

Whether these information utilities are actually allowed to operate on a “for profit” basis is an issue still under discussion in many jurisdictions.

3.2 Information Utilities

With authors (Somavia, 1977) commenting that the demand for information is “ *a basic need, both for individuals and societies, and one of the fundamental human rights...*,” and the fact that there is now an opportunity to charge transaction-based fees for services rendered, it should be no surprise to find fierce international competition for the rights to satisfy this need for information.

Considering the fundamental place of land in our existence, and the fact that comprehensive land information was usually available within the government domain only – depending on the country, of course – land and land-related information becomes even more valuable when considered from a business perspective.

Competing to partner with government in a land information utility, or to win the now common Build-Operate-Transfer contracts, necessitates a careful review and a thorough understanding of the land information business, as well as the processes and functions thereof. In some of the jurisdictions that have embarked upon a privatization/re-engineering effort, this has resulted in the following:

- Achievement of better understanding of the land management business needs, processes, and issues of more people and organizations – many of whom were not traditional participants in the land management industry
- Development of improved processes, organizational structures, management practice, legislation, and technologies focused on land and land information management – often specific to a jurisdiction, but some also suitable for deployment in other jurisdictions

Those organizations that participated as consultants, technology suppliers, or successful bidders during the privatization/re-engineering activities often attempt to capitalize on their newly developed expertise by expanding their business operations and marketing efforts into other jurisdictions and countries. Their competitors do the same to recoup money invested in competing for contracts.

Establishing effective and functional public-private land information management/land record management enterprises to meet market demands requires large investments. In many cases, the projected period before any real return is shown to be 10 years or longer. For these “national” information utility ventures to maximize their revenues and return profits to their investors, some turn to the utilization of economies of scale.

It is becoming commonplace for these organizations to enter into partnerships and joint ventures with complementary ventures and organizations to offer their expertise, facilities, technologies and services to other countries and regions.

This trend is fueling the “industry globalization” driving force, which is in turn driven by the demand for land information, derived products and government–level service delivery improvement in different regions and jurisdictions.

Regulatory influences and government policy changes impact the land management industry both nationally and internationally. These changes are resulting in the development of industry-specific solutions and technologies, improved processes, and new *products* and services derived from land information. The increased activity in the industry and demand created thereby are also causing the number of participants in the industry, both at a national and international level, to change.

3.3 Technological Change

The combination of changes in government policy and regulations and technology presents a major driving force to changes in the land management and land information management industries.

To achieve objectives of affordable, effective production and delivering the appropriate information product to the desired point of consumption at the required time, the land information industry (still very much a government-centered industry) continues to drive suppliers of technology to deliver technology and solutions that enable better achievement of industry objectives.

Simultaneously, advances in different technologies are impacting the land management industry. Five technologies, which have major impacts on the land information industry, are:

1. Internet technologies
2. change management technology
3. data management
4. advances in systems integration / interoperability technologies
5. standards and positioning / primary data capture technology

Some of these are expanded upon below.

3.4 The Internet, interoperability and data sharing

With the Internet becoming available in more locations and accessible to more people, the demand for online access to land information is increasing. The demand for online land transactions is also on the rise – partly due to the globalization of land information technology, best practices in public administration, and the entry of national information utilities into the international marketplace.

The possibilities afforded by the available Internet and interoperability technologies are placing pressure on outdated practices, methods, and structures where they still exist within a land management enterprise.

When these technologies have been implemented in land management enterprises, they very clearly identified that problems experienced in sharing data or obtaining access to someone else's data have become more *political* in nature than *technical*.

As consumers we have daily contact with efficient private sector businesses, which are making full use of these technologies to improve the convenience of doing business with them. The convenient business interface provided by the private sector contrasts strongly with the bureaucratic government environment still prevalent in many land agencies and other government departments.

As government moves towards the implementation of online services, "one-stop shopping", and integrated service delivery, consumer choice and accessibility should still be key concerns. Some consumers may choose not to transact business online or may not have access to the Internet, a telephone or a computer. These consumers should not be ignored in the evolution of government service delivery and the re-engineering or modernization of a land management infrastructure.

The principles to which the electronic services provided by government should conform, as outlined in the 1996 prospectus for Britain's government.direct initiative, provides a strong foundation to build upon for others considering electronic service delivery. These principles are summarized in Appendix A.

The impact of the Internet, interoperability, and data sharing on the land management industry has already manifested itself in implementations around the globe. We no longer have to speculate what the impact is – we now have to plan and prepare to meet the challenges presented by these technologies.

Coleman and McLaughlin (1996) noted that *"the wider notion of global communications and connectivity within and between organisations – can be unsettling to the institutions traditionally involved in spatial data distribution and land administration. By design, the chaotic structure of the Internet itself defies traditional notions of control. Empowering individuals to obtain and evaluate new technical information, advice and market conditions from Internet e-mail and news groups certainly changes traditional lines of information flow within an organisation. ...The ability to provide information to outsiders in the same manner will certainly be a mixed blessing to many organisations where security is a concern and/or information is considered a saleable commodity"*.

They also summarize challenges presented by these technologies in stating *"improving on-line access to one's organisation and information holdings via the Internet invites inspection by hundreds of new and different users with little appreciation or understanding of product limitations or traditional practices. By default it opens up the organisation's products, access mechanisms and policies to international scrutiny. While this is healthy in the long term, it may nevertheless require additional system resources and add to overhead. While the new mix of system and people resources will become*

clear over the longer term, the organisation must be able to withstand a period where the imbalance between these two will affect its ability to service customers effectively."

McLaughlin and Coleman further anticipate the Internet's key threat to organizations to be the rapid changes to accepted products, procedures, and policy that will have to be implemented due to actions and demands from sources which have been peripheral to the original business of the organization. These changes will be hard to anticipate. They will also have a direct impact on the continued viability and relevance of the information products offered by organizations, and even on the continued relevance and viability of the organization itself.

The liability risks associated with making data available are another major impact of data sharing and Internet access on the land information management industry. This is resulting in careful procedural and quality assurance reviews, and in some cases, organizations have decided to delay or postpone the availability of online access to land information, electronic land transactions, and data sharing.

What has become clear is that while technology can provide most of what is needed to solve the problems of production and distribution, technology alone is not enough to deliver the most effective and least expensive production and product distribution systems. Organizational, political, and other non-technology barriers prevent the implementation of *ideal* systems.

4. Information Technology Trends in Land Information Management

4.1 From Back-Office to Points of Consumption

For a long time, land management and administration agencies have been using various technologies to improve their processes and operations. They have naturally also been making extensive use of information technology, although mostly in the back-office. The back-office was the place where calculations were done, data captured, and maps plotted. The customer service desk was not always the beneficiary of user-friendly self-help terminals, or even staff-assisted inquiry systems. Current trends encourage the use of information technology to further automate and streamline operations by providing automated interfaces and delivery systems to the various points of product consumption.

4.2 In-House Developed Systems vs. Appropriate Industry/Commercial Standard Systems

Computer systems and databases used in many land agencies were often very specialized in-house developed systems. With the removal of international trade barriers, political reform in many countries and the free flow of information on a global scale, we now see these specialized – and often outdated systems – being replaced by systems comprised of standard commercial software and hardware components. This trend presents challenges to the land information technology suppliers and information utilities active in the international market.

One of these challenges is to attain a balance between capabilities attractive and usable to a global marketplace while also providing the special capabilities, functions, and workflow to which users of in-house specialized systems have become accustomed.

Another challenge is the provision of system solutions within the confines of in-country technology and resource capabilities and limitations. In other words, providing solutions and technology that are appropriate and sustainable can be difficult, given the available or expected resources and infrastructure.

The need to use appropriate and sustainable technology and solutions in support of land and cadastral management is supported by the conclusions reached by a group of industry professionals during the 1996 International Land Tenure Conference and Administration in Orlando, Florida, USA. Their conclusions appear in Appendix B.

5. Traditional Approaches Are Being Questioned Due to Technological Advances

The advances in information positioning technology require us to revisit long held assumptions and approaches. For example:

5.1 Data Migration and Capture

In the past, when upgrading a system or moving to a different software or technology platform, the migration of data from the legacy system to the new system was usually an accepted practice.

Today, the availability of spatial data server technology such as that provided by GeoMedia® makes it possible to maintain certain data sets in their legacy formats while incrementally migrating data to a new non-proprietary environment and updating it on an as-needed or most-actively-used basis.

5.2 "Measurement Related" Cadastres

"Measurement related" cadastres or measurement-based cadastres were an implementation dream for many years. Research has been on going into the methods and techniques for implementing a land information management environment. This environment needs to be strongly aware of the relationships between objects in the system and their respective original sources, as well as the interaction between these objects.

Generally speaking, "measurement related" cadastres were deemed practical when a solid and extensive geodetic and survey framework could be used as the foundation. Establishing survey and geodetic control networks and tying surveys to national or regional grids became much more affordable and easier to implement with the availability of high accuracy GPS systems.

Functional deployment of such "measurement related" cadastral systems have been delayed due to the fact that very few institutions were willing to invest in custom technology development for this purpose. These systems have also been delayed because they have not offered sufficient benefits.

However, commercially available technology has advanced far enough to now make the implementation of such systems commercially feasible and viable. And we are seeing actual implementation of "measurement related" cadastral systems/LIS becoming more frequent.

5.3 Data Management and the Information Infrastructure

Over the last few years, land information management enterprises have radically shifted the focus of their information management technologies. For example:

1. Data is being collected at an ever-accelerating rate, largely as a result of deploying increasingly powerful electronic acquisition equipment such as GPS and remote sensing satellites. Interoperability, data exchange, and networking developments allow huge volumes of data to be exchanged and migrated into newer architectures and data formats.
2. Land information enterprises have to store and retrieve this data efficiently, and make it accessible to all users, enterprisewide.
3. This data must be available across multiple databases and hardware platforms, in both multi-user and client/server networked environments.
4. Data integrity, organizational ownership, and security must be maintained.

Driven by the need for land information systems, management information systems, and other enterprise systems to share data, enterprises can no longer define data in proprietary data structures or strand it on application-specific islands. Data needs to be integrated and shared. Achieving the required level of integration and data sharing using only traditional GIS or LIS technology has proven to be ineffective.

Peter F. Drucker, one of the fathers of management theory, argued convincingly that the technological boundaries between industries have been erased in a recent article [*Forbes*, October 5, 1998]. In our case, what used to be *land information systems* have become *information systems*. We now deploy commercially available technology from the traditional *data management* industry and vendors, such as Oracle and Microsoft, to meet the four business requirements listed above.

By incorporating spatial data into the relational database so that it is functionally available to all applications across an enterprise, not only spatial applications, it can be ensured that many of the modern enterprise data management needs can be met.

6. Summary

Market forces drive demands for technology. The combination of changes in government policy and regulations and technology is probably the major driving force for change in the land management and land information management industries. This has multiple impacts for the cadastral/LIS industry. It also has major consequences for the land-related and land information-related professions.

Van der Molen [1998] aptly summarizes the major trends in the land management industry as follows:

- Increasing awareness that decisions on systems of land tenure, land registry, and cadastre should only be taken after considering the local, social, cultural, and political contexts
- Growing trend of integrated service delivery from government and government agencies at all levels to citizens and businesses, which will demand that geodata providers adopt this paradigm and cooperate with government agencies in the realization of integrated service delivery
- Greater prevalence of data sharing
- The Internet – and its successor(s) – will provide the infrastructure for disseminating land information

What has become clear is that while technology can provide most of what is needed to provide true multipurpose land information systems and networks, technology alone is not enough to deliver the most appropriate, sustainable, cost-effective, and functional environments and infrastructures. Organizational, political, and other non-technology barriers prevent the implementation of “ideal” systems.

Land information management infrastructures and their supporting technologies cannot be considered or effectively implemented without considering other components and industries, that when combined, make up the total land management and administration community.

While technology, including information management technology, is important in land management and administration, it must be remembered that it is a means to an end.

Implementing a *modern* land management infrastructure presents several challenges. One challenge is understanding the traditional land tenure arrangements and cultures in the destination jurisdiction well enough to accurately record, represent, and model the full context and intricacies thereof in a computerized environment, while also attempting to transfer best practices and technology.

We try to accomplish this without eroding a culture and its values or alienating the people of such cultures from their own land managers and land administrators in the process.

Jurisdictions embarking on LIS implementations, upgrades and re-engineering efforts could expect to see competition for their business from unexpected participants and could expect to receive a wider range of differing proposals than expected.

Probably the most important understanding we have to arrive at is that land management and land administration is about much more than successfully integrating multiple disciplines and technologies. It is also about people, their future, their dreams, and their reasonable expectations. It is about cultural values and traditions. The management and use of land information should take this into consideration.

The land information enterprises should apply, manage, and utilize this very valuable resource of land information with the utmost care and responsibility. The cost of the required information products must be affordable and acceptable. The value and purpose of information is lost if it is not available for decision-makers. Decision-makers not seeking and using the best available land (and other) information will be guilty of grave neglect. The evolving open information society will expose neglectful and ineffective organizations and decision-makers.

We are now faced with many choices and opportunities. New technologies can help us make better use of that most precious resource of all – the Earth.

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Appendix A

Summary of Principles to which Electronic Service Delivery by Government Should Conform

This is a summary of "A Prospectus for the *government.direct* Electronic Delivery of Services," published by The Stationery Office Limited of London in November 1996.

The *government.direct* initiative in the United Kingdom proposes the following principles to which electronic service delivery should conform:

1. Cost-Effective and Affordable

Services should be provided such that they are cost-effective and affordable.

2. Choice

Aim to make electronic direct services the preferred option for the majority of consumers, whilst still providing traditional face-to-face, telephone, or paper-based service to those people and groups not willing or able to use electronic services.

3. Confidence

Visually safeguard personal and other sensitive information collected from individuals and businesses. Consumers should be able to understand how this is achieved and should have access to their own data. Ensure that information is kept and used in accordance with the principles of data protection law.

4. Accessibility

Opportunities afforded by information technology should be used to simplify intra-government interaction, as well as interactions between government and the public. Services should be available where, how, and when consumers require them. "One-stop-shopping" government services, convenient public access terminals – also in remote areas and for those with limited mobility, round the clock availability, and language choice are some of the challenges that are to be met.

5. Efficiency

Streamline and integrate processes across the boundaries between government agencies. These boundaries should become invisible to the consumer.

Simplify and automate routine processes. This will reduce the need for manual operations and paper-handling – especially in the areas of information transfer and dissemination.

Consumers should be able to obtain near real-time responses where practical. Where near real-time responses are not possible, electronic progress reports should be available to track the progress of a consumer's requests or cases.

6. Rationalisation

Provide for the sharing of functions, resources, processes, and data common to more than one department. The benefits are expected to be simplified systems and reduced costs.

Information sharing between departments should naturally be subject to the legal provisions therefore.

7. Open Information

Make government information available electronically – except information that has to be withheld to protect personal or commercial information or in the public interest.

Electronic information should be available in non-proprietary formats and such formats should assist the government in improving competitiveness and transparent government.

8. Fraud Prevention

Public funds and resources should be protected from fraud and misuse. Systems should include measures to establish the identity of consumers dealing with government.

Systems should also protect information from being incorrectly accessed or manipulated.

Appendix B

The Role and Implementation of Technology

During the International Land Tenure Conference and Administration in Orlando, Florida, USA (November 12 – 14, 1996), a group of about 20 industry professionals met, including representatives from consultant companies, donor agencies, land registration agencies, universities, and GIS and GPS companies. These citizens from both OECD and developing countries deliberated on the role and implementation of technology in land management and administration and concluded the following:

Role

- That it should be used at all stages of land administration programs – survey and mapping, the adjudication and document preparation stage, and the ongoing operations stage, as appropriate
- That appropriate technology can mean any technology, high or low, which is cost effective, is within the capacity of the country or agencies involved, and can be maintained within the means of the agency/country
- Technology is subservient to the objectives of the total project
- It should have a primary focus on the project objectives and client requirements
- It is not the end, it is one of the means
- That the technology must be affordable after the close of a project
- That technology relates to and involves:
 - Data (its structure and management)
 - People (customer requirements, capacity, staff training, nationals, traditions)
 - The processes involved – systems
 - Equipment – hardware and software
 - And these factors all form part of the design for use
- For affordability reasons for smaller economies, standardised or model applications should be developed (the principles – not the model)
- Legal aspects of IT use should be considered early: acceptance of electronic and computer generated documents as legal evidence; archiving; and always having a disaster copy of the records off-site
- Ethics should be part of technology transfer and sales
- That studies should be undertaken on project costs – carefully comparing like with like

Implementation

- A “Program Technology Business Plan” is necessary, which includes laying out a street map for the project and beyond. It includes: objectives, business requirements, purpose/use; primary output or function; implementation strategy with stages and phasing, institutional matters, staffing, training, life cycle costs,

procurement strategy, maintenance, and replacement. This is done at an early stage of project design.

- The objectives and use of any part of technology should be stated clearly up front – otherwise, do not buy it.
- A life cycle approach should be taken in its planning, use and budgeting.
- The specifications/terms of reference for IT should be written independent of the technology approach; i.e., in terms of the objectives, product and function, not in terms of the technologies or method to produce a product. In this manner, emerging technologies can best be considered for the project/program. Bidders can propose optimal solutions involving appropriate technologies and methods.
- Data specifications should be written independently of technology and particular commercial products – they should be generic.
- Appropriate resources and budget must be available for application writing in IT, as well as for maintenance.
- Build technology capacity in-country.
- The technology transfer should take place to national people with all technology use, and they should be involved with all stages of the technology processes including design and maintenance. This will mean training to achieve this. Methods to achieve this participation must be further developed.
- The bidding process (procurement) for IT and other technology must be done carefully, and according to a schedule. It often includes equipment – hardware, software, and services (e.g. application writing and training) bid together. The bid ratio of price to service and technical skills of bidders must be decided carefully, stated in the bidding documents, and evaluated carefully.
- That both agency and donor project managers need technical advisers for IT, GPS, GIS/LIS.

Lynn Holstein – chairman and reporter: November 14, 1996 Draft #1.

Corporate Description

Intergraph technology helps our customers discover new ways to manage and use geographically referenced information, promoting informed decisions and improving productivity. Our products are used throughout the LIS industry and are the standard by which other products are measured.

Analysts continue to rank Intergraph Corporation as the world's leading supplier of GIS and mapping solutions. Intergraph is a billion-dollar supplier of hardware, software, and services with sales and support offices in 65 countries. Our products reflect 30 years of experience in identifying and meeting the unique requirements of graphics-based applications.

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