

An Investigation into the Feasibility of a Collaborative Approach to an Effective Cadastre Information Model

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Abstract

Effective management and protection of society's increasingly complex and inter-dependent infrastructure depends upon understanding where that infrastructure is and where it is in relationship to its surrounding environment. Yet, those who build, protect and maintain our nations' infrastructure continue to struggle to collaborate effectively. This is at least partially due to the inability of organisations working in the same areas to exchange their spatial information.

The basic framework for spatial information exchange is the cadastre. The technology exists for the sharing of information. Government funding and legislation has spurred the creation of numerous cadastre models but they are often less effective than planned. In many areas supporting legislation or funding from a federal, state or provincial government may not be forthcoming. Developing agreement across a broad constituency is a daunting task. There are technical, legal and policy hurdles to resolve before such models are implemented. For stakeholders who operate over a large jurisdiction and who share a need to exchange spatial information between them is there an opportunity to collaborate on establishing a sustainable cadastre information model to enable that data sharing?

This literature review attempts to answer that question. The stakes seem high enough. Requirements for spatial data sharing and collaboration include public safety, both for the oversight of critical infrastructure and Emergency Response. First Responders require a base cadastral framework to allow the fast and effective exchange of geographic information. There are significant economic and societal benefits generated by increased spatial information sharing. Spatial information exchange can produce measurable return on investment for the business community. The core fundamental enabler of that information exchange is the cadastral data, and to be effective, all involved parties must be working from the same cadastral information model.

Definition of a cadastral information model has many technical components, most of which have been thoroughly addressed by government, private enterprise and academia. Information is scarcer, however, on how to mobilize diverse groups of stakeholders to adopt, implement and sustain one of these models commonly across multiple local governmental jurisdictions.

Organisations such as the Geospatial Information and Technology Association (GITA) have brought regional stakeholder groups together to address the need and barriers to ongoing collaboration. The need for a common cadastre information model is widely cited as a reason why spatial information is not currently being shared. Concerns about privacy and security are other barriers that also impede progress toward resolving the cadastre issue. Although

geospatial information technology is a technical field, few see the main barriers to sharing as technical in nature.

Government legislation and funding have been employed with success to create common cadastre models and legislative mechanisms often support the sustainment of those models. Despite the advantages of working from a common cadastre, there is often resistance to adoption of these legislated models, and many of the potential benefits of information exchange remain unrealized long after implementation.

If knowledge sharing can indeed only be voluntary, and not conscripted, then perhaps a collaborative approach could not only work, but could have distinct advantages over one that is imposed. Indeed, Knowledge Management (KM) principles suggest that knowledge is shared most successfully in a voluntary framework where stakeholders come together for a common purpose in an environment that engages various parties in a way that is most suitable for the role they intend to play in that community. The Integrated Cadastral Information Society in British Columbia has experienced this in their efforts to implement a cadastre information model across that province.

Bringing a diverse group together and developing agreement also requires leadership that does not rely on positional authority, and given the technical demands of sharing spatial data between various organisations, it will take effective operations and IT management.

The experience of ICIS and KM best practices indicate that good results can be achieved, but there must be a willingness to invest significant time and effort in the process. The full implementation of a cadastre model may take longer where there is no supporting government legislation or funding, but adoption rates are likely to be higher given the focus on building relationships and trust early in the process.

1. Introduction

As far back as the 1998 Presidential Commission on Critical Infrastructure Protection (GITA, 2008) we have been warned that security, economic prosperity, and the social well-being of a nation depend on the reliable functioning of increasingly complex and interdependent infrastructures. Yet even in a post 9/11 world those who build, maintain and protect that infrastructure still struggle to collaborate effectively (GIS Development, 2009) (Zeiss, 2009), largely due to their inability to answer one fundamental question: Where? Business activities are highly integrated, and an organisation's Geospatial Information System (GIS) is only as effective as its capability to integrate its information with the external environment which provides context. In addition, those involved recognize the increasing interdependencies involved in Critical Infrastructure Protection (GITA, 2008). With modern spatial tools and software what stands in the way of integration doesn't appear to be a lack of technology, but rather the lack of functioning frameworks for spatial data sharing.

At the heart of most spatial data sharing initiatives is the need for a common cadastre framework, a digital data set describing the spatial boundaries of property boundaries. The technical definitions of the spatial data, as well as the policies, procedures and supporting IT infrastructure that enables organized spatial data exchange (Ajmar, Perez, Terzo, p. 1098) are known as a Spatial Data Infrastructure, or SDI. SDIs are, among other purposes, the practical instruments for realizing a functioning Cadastre Information Model as described in Appendix A. Predominately, however, functioning cadastral information models have been supported by provincial or national legislation. In some jurisdictions such legislation has not been forthcoming, so can an effective cadastral information model be implemented across multiple jurisdictions working within a collaborative, non-legislated environment to voluntarily share spatial data? This study will attempt to answer this question by focusing upon the particular challenges facing a voluntary approach to developing and implementing a cadastre information model. It will look at strategies for overcoming those challenges. It will address issues related to developing a functional model for the continual sharing of information between various governments and utility firms

This issue is being faced by Provinces, States and countries around the globe, and it is the problem being faced by the Integrated Cadastral Information Society (ICIS) in British Columbia (Flagg, 2008). Different jurisdictions have different views of what is required of a cadastre information model, but most agree that common implementation of a single model is preferable to multiple cadastre models covering the same territory. The effort and confusion caused by separately created and maintained individual cadastre information models are many. Yet, there are competing requirements that make agreeing upon a single model for all stakeholders no easy task. Fundamentally, a collaborative model

for creating, populating and maintaining an integrated cadastre information model could be considered successful if the time and effort to work through the challenges of doing so without an enabling legislative framework proved more beneficial to participants than waiting for such legislation

The following literature review includes selections of material that speak to the reasons for, and the commonly encountered issues related to data sharing. Further literature is reviewed that explores the particular issues related to creating, implementing and sustaining a working Spatial Data Infrastructure (SDI). Also included in the Literature Review is material that addresses the dynamics of information exchange in Communities of Practice (COP). Communities of Practice are groups of people who come together voluntarily to share information in order to solve a problem (Wenger, McDermott, Snyder, 2002) given that this describes the stakeholders of a collaborative SDI issues relating to Communities of Practice are relevant to this study. Available literature that goes beyond theoretical SDI frameworks or the establishment of frameworks is limited, and such information as has been uncovered will be reviewed to determine the levels of success various cadastre information models have achieved and to analyze the frameworks which support them. Based upon the findings of the literature the paper concludes that a collaborative approach to implementing a cadastre information model is indeed possible, but such implementations could still benefit from legislative enablers as long as those enablers do not serve to simply replace collaboration with compliance.

2. Literature Review

2.1. The Case for Sharing Spatial Information

Emergency Response

The National Academy of Science's publication *Successful Response Starts with a Map* (2008) outlines the critical importance of geospatial information technology (GIT) in effective response to natural disasters. Disasters all have 'temporal and geographic' characteristics that responders can best understand with GIT analytics. One of the biggest challenges to providing the required analysis includes getting timely access to accurate data from the various stewards of relevant information. It is common for emergency response efforts to be stymied by the lack of preparation in this area, with few areas having neither established data sharing agreements nor pre-disaster data sharing procedures in place. With data security cited as one of the main reasons organisations don't share spatial information ahead of a disaster a key priority for preparedness needs to be a proactive approach to establishing frameworks and security policies. Other important activities for emergency preparedness include establishment of backup and data redundancy procedures, needs assessments and training for those who will be asked to work with GIT outputs. Finally, funding has been identified as inadequate to the task given the importance of preparedness in emergency response.

The American Association of Geographers collaborated with the National Science Foundation to compile a collection of papers on the geographical dimensions of terrorism. The resulting book "The Geographical Dimensions of Terrorism" (Cutter, S. 2003) covers a variety of topics which are categorized into some broader subject categories such as the "Societal Response to Threats", "Geospatial Data and Technologies in Times of Crisis" and "Building a Safer but Open Society" (Cutter, S. 2003). There are a number of papers that address issues of terrorism and touch on spatial data and technology only peripherally, but there are many that speak directly to the technical, societal and procedural challenges related to using and sharing spatial information.

In one article, Michael Goodchild, considered by many to be the father of Geospatial Information Systems, speaks on "Data Modeling for Emergencies." In it he discusses the advantage of modeling spatial data with multiple purposes in mind, knowing that the data and elements modeled may be called upon to serve a purpose other than a single application or routine lifecycle management might require (Cutter, 2003, p. 106). This is just the kind of design consideration for a cadastre information model required to serve the disparate requirements of many users, often in the service of emergency preparedness, response and recovery. Michael also speaks of the challenge in modeling spatial information for different uses where levels of scale and detail may present very different requirements.

Other articles address the challenges that cross jurisdictional emergencies present and point to the benefit of commonly adopted standard models so that when emergency events, whether man made or naturally occurring, impact large areas across multiple jurisdictions, important spatial information can be quickly marshaled if not ahead of time, at least in immediate response.

Critical Infrastructure Protection

Also focusing on risk response and mitigation benefits of spatial information exchange is GITA's white paper "The Geospatial Dimensions of Critical Infrastructure and Emergency Response: Spatial Infrastructures". Moeller and Shannon discuss the key issues related to Spatial Data Infrastructures in relation to Critical Infrastructure interdependencies. Spatial Data Infrastructure (SDI) can be considered a super-set of a Cadastre Data Model as it includes cadastre, but encompasses other spatial information including utility and government infrastructure data, such as the pipelines, communications towers, power generation plants and much more.

The paper is written from the perspective of the current situation regarding the condition of infrastructure, both civil and private. That is that a huge investment is required in North America in order to maintain seriously deteriorating roads, bridges, pipelines, power lines and other publically and privately owned assets. These are assets which are critical to the needs of the population, are at risk, and which need to be protected. The paper explains that managing this risk depends largely on each stakeholder having a clear understanding of the relationship between and interdependencies of each others infrastructure, and that an SDI is the mechanism for enabling the sharing of spatial data required to provide that clarity of understanding.

Some of the key points discussed in this paper are the need to define and agree upon a technical and procedural model for collaboratively sharing spatial information, and to ensure that this SDI is in place and operational before an emergency situation arises. GITA's paper also explains how local events can have regional or national implications because of infrastructure interdependencies.

All the issues addressed in the paper point to why a common cadastre model needs to be more than a technical standard. It should be something that is effectively implemented. The issues raised in GITA's paper would seem to indicate there are too many affected stakeholders to wait for a cadastre information model to be legislated by one of those stakeholders, however critical that stakeholder may be.

Operations

For a broader operational perspective on the need for spatial information exchange, Dave Chapman and Pat Weber's article "Investing in geography: A GIS to support inward investment" published in *Computers, Environment and Urban Systems* in 2009 shows extensive examples of the value of compiling data from diverse sources onto a common spatial framework. Few of the examples use cadastre data sets specifically, many of the data sets were derived from parcel data sources, and the successful combination of diverse spatial data sets was either a simple matter of combining and analyzing the data, or it was a tedious, labor intensive process of merging data from disparate frameworks. The value demonstrated in these examples can lead one to conclude it would be beneficial if the process were easier rather than more difficult. That is, there would be increased opportunity to derive value from the data in these examples if based upon a common cadastre information model.

The research done here represents an example of the kind of societal and economic benefit spatial data sharing between stakeholders can deliver, as suggested by Kristenson in Pete Flagg's white paper in *Risks and Benefits of Spatial Data Sharing* (2008).

Chapman and Weber show GIS being used to provide social benefits (2009, p. 5) and economic development (Chapman & Weber, 2009, p. 4) as well. One finding of their interviews showed that there was consistently little correspondence between business activity and municipal boundaries. This is one of the drivers for a Cadastre Information Model that bridges local government boundaries: Those who can make use of the data are often concerned with areas that aren't geo-political in nature. At the same time, for firms that are requiring municipal consents do need to know where those boundaries are.

In addition, the studies also showed that gathering external spatial information and combining it with their own was also useful to the specific local governments in helping them better understand the characteristics of their own cities (Chapman & Weber, 2009, p. 7-8). This is an interesting point as it provides a potential value proposition for local governments who traditionally have been less interested in adopting cross jurisdictional spatial data models. From a geographic perspective municipalities often see themselves as self contained much more so than utilities, provincial or federal governments whose concerns are geographically more diverse.

The paper concludes that the benefits proven by their research point to the importance of investing in integration of GIS capabilities through the implementation of a core model. This is not a specific call for a cross jurisdictional cadastre information model; it certainly supports many of the same principles and objectives, such as easier access to more information promoting

increased insight, understanding and enhanced decision support by all parties to a community objective.

The “Business Case”

In “The Business Benefits of GIS – An ROI Approach” Ross Smith and David Maguire lay out a business benefits driven approach to geospatial investment. This is particularly relevant to the issue of a Cadastre Information Model for a couple of reasons.

First, the stakeholders in a commonly developed and adopted cadastre model must be able to identify business benefit to the cost in human and capital resources to justify their participation. Some headway may be made on the premise that it’s ‘the right thing to do’ but for a sustainable effort, it is necessary to link the activity to internal business benefits.

Secondly this book steps the reader through how to make the linkages between business requirements and possible GIS investments. In many of the examples, the sharing of spatial information between a firm and regulating agencies, permitting authorities and other business partners is identified as a potential business benefit as increased ability to share spatial information can lower costs and reduce cycle times. The point is made to support how individual businesses or local governments approach their own geospatial architecture of data schema, applications design and work flow.

The methodology reminds practitioners that design considerations have cost implications and as such must tie back to the delivery of a tangible business benefit. In some cases, there can be tangible benefits to data sharing between organisations, such as reduced turn around time for utilities when submitting applications for municipal consent to construct service delivery infrastructure in public rights of way. For example, turn around times can be shortened by replacing a manual work flow with an automated one in which permitting authorities can more efficiently evaluate the potential impacts of such works. A cadastre model that allows this data sharing would be one of those key enablers but such an activity specifically is not the focus of the publication.

2.2. Defining the Cadastre Information Model

If a substantial portion of the benefits of GIS relate to the sharing spatial information, a substantial portion of the effectiveness of that sharing depends upon a common cadastre. Carsten Rönndorf of the Ordnance Survey suggests “A consistent and accurate base data framework “ with broad coverage is a critical enabler of the quality of that information exchange (Rönndorf, 2008)

The US standard for a cadastre data model was developed and published in 2008 by the US Federal Geospatial Data Committee under the title “Cadastral

Data Content Standard for the National Spatial Data Infrastructure” (FGDC, 2008). It is a technical standard for capturing and sharing spatial cadastral data in the United States and is often referenced as a standard in Canada as well, as are many of the FGDC standards.

This document is focused on the structure of the cadastre information model. In fact this FGDC standard specifically states that it is not an implementation standard (FGDC, 2008, p. 5). While the focus of this research paper is on the organisational aspects of implementing a collaborative model this paper does as clear a job as any in defining just what constitutes a cadastre data model.

The FGDC states five objectives for the standard (FGDC, 2008, p.5). Two of the objectives relate to developing common definitions and developing a common language to increase the effectiveness of cross entity communication. Another is to ‘suggest’ attribute values to facilitate data sharing and another is to provide guidance for federal workers such as surveyors and Land Information System (LIS) employees. The fifth goal is to reach out beyond the federal arena by engaging outside participation in development of the standard.

It indicates here at least some acknowledgement of the need for voluntary participation. It also suggests that while there is some acknowledgement of non-federal participants that the focus of the FGDC is very much internal, focusing on federal requirements.

The standard also notes that it has attempted to align with other existing standards that have some degree of overlap. This issue points to a common challenge not just in developing, but in implementing any cadastre data model. Most governments and utilities are not starting from scratch but each already has existing data which constitute internal standards due to the need to maintain the data, and the dependencies of other data sets and applications which may be coded to depend on the data being in its current structure. Getting a group of various agencies and firms to agree to a cadastre data model also requires getting these stakeholders to agree to take on the effort and cost associated with complying with the model.

The FGDC standard also references the need to capture meta-data that points to the source of any compiled cadastre data (FGDC, 2008, p. 4). This is not a trivial issue as the decision to use information is directly related to the reliability of the source of the data, not just who supplied it, but where they got it from originally. This is particularly true when business decisions are based on this data, decisions such as where to dispatch an ambulance, or whether or not it’s safe to dig in a particular location.

The standard includes significant explanation of Universal Modeling Language (UML) which is used to describe the conceptual and logical cadastre data model. It does a good job of modeling out the spatial characteristics of the elements

within a cadastre data model. Spatial data has some unique characteristics such as elements that are physically within or which intersect each other.

In “Further Progress in the Development of the Core Cadastral Domain Model”, a paper with a European perspective, the progress toward development of a cadastre data model is reviewed. Various characteristics emerge beyond a basic parcel geometry view of the cadastre model including issues such as defining 3D elements such as individually titled multi story apartment units. Much effort has clearly been expended in developing a model that considers tenure and rights issues (Lemmen et. al. 2005, p. 14) as well as taxation (p. 5). The Core Cadastral Domain model has been developed under the direction of FIG, the International Federation of Surveyors, and it attempts to define a cadastral model that can accommodate common European variations such as longstanding land tenures for which there exist no historical land survey of the property boundaries. There is a clear linkage to land registration, although they discuss cadastral models which have been designed to accommodate. Other models are compared.

Hungary’s current model is presented as a success though as of 2005 only 5% of tenured parcels in that country were modeled in the national cadastral data set issues (Lemmen et. al. 2005, p. 10).

Despite significant and thorough technical work in developing what they refer to as the Core Cadastral Domain Model (CCDM), they note that there is a vacuum of leadership and they suggest perhaps financial institutions have sufficient interest in the matter to provide the impetus to move things forward. There is a need for better communication to spur development and adoption of the model. Another indication that it is not uncommon for technical definitions of cadastre models to precede a buy in from the communities of interested parties is the volume of references in the paper’s literature review pointing to cadastre models that require momentum spurring actual use of the models.

The refinement of the CCDM has grown in complexity since its inception in 2000, and that complexity has slowed attempts to put the model into use. In what seems to be a response to this the CCDM has noted certain domains it will consider out of scope for the CCDM. These exclusions include infrastructure facilities data as well as address data and building envelope information and imagery. These and other exclusions prove problematic however as most are tightly coupled in purpose to cadastre information.

With so many different parties each with different and specific business requirements interoperability is seen as an important characteristic of a successful model (Lemmen et. al. 2005, p. 24)., as it the need to accommodate methods for recording quality characteristics (p. 7) and temporal information about the parcels (p. 23).

While the models complexity may make it adaptable to many situations, there is a need for core standards across the countries where the FIG CCDM is intended to be implemented.

Both the FGDC and the EU's FIG documents represent useful data frameworks for a cadastre data model, and while both of these organisations help define the 'what' issue of a cadastre information model; there is little in these documents to address the focus of this research which is more related to the 'how'.

In "WFP Spatial Data Infrastructure (SDI) Implementation in Support of Emergency Management" (2008) Ajmar, Perez, and Terzo's paper suggests metrics measuring societal benefits address the degrees of awareness and access to spatial information by citizens. They propose metrics that measure progress on the creation of key base data, including cadastre. Metrics in this area should include reporting on the completeness, accuracy and currency of the data. Many of their proposed metrics do focus on cataloguing efforts, creating a data bank of what spatial technology and IT is being used where and by whom particularly in relation to those technologies that enable open sharing and collaboration of spatial information. Such information does indicate that use, or adoption, of an SDI is a key indicator of its success. In addition Ajmar, Perez and Terzo propose several metrics regarding governance as well, acknowledging more than just the technical aspects of an SDI.

2.3. Realizing the Potential for Spatial Data Infrastructures

Ajmar, Perez, and Terzo look at a Spatial Data Infrastructure (SDI) for the purposes of reducing redundancy and increasing the efficiency and effectiveness of spatial data exchange in support of Emergency Management efforts of the United Nations. In "WFP Spatial Data Infrastructure (SDI) Implementation in Support of Emergency Management" (2008) the authors explain that while spatial information analysis is a key component in delivering the right emergency response the areas that need it the most, they also see use of spatial data within different UN component organisation silos making the practice less effective than if everyone was able to access spatial information seamlessly across organisational boundaries. Their approach to addressing the problem is focused on the technical issues, even to point of prescribing specific commercial software applications. The reasoning is that even when data is shared it is often unusable due to differences in the standards and practices under which the information is compiled, maintained and distributed.

Other literature goes beyond the reason why and the technical aspects of how to create a model for exchanging spatial information to address implementation. In the 2009 white paper from a subcommittee of the National Geospatial Advisory Committee, 'Proposal to Measure Progress Toward Realizing the NSDI Vision' (Gorham et. al. 2009) a proposal is put forth to implement metrics in order to

drive progress in the United States of America toward achieving a functioning spatial data infrastructure. Most interesting to note is that while discussions surrounding spatial data infrastructures often focuses on the data and technological issues, data and technology constituted but two of five categories of metrics the authors of this report outlined.

The report mentions that the task of defining and implementing a national spatial data infrastructure is made more complex due to the massive increase in the amount of data being created and distributed by the private sector. The inference seems to be that data created and managed by government provides a more easily managed resource. The perspective explicitly stated is that a national spatial data infrastructure as an instrument of control and regulation rather than simply provisioning of an underlying framework infrastructure enabling data cataloguing, discovery and sharing. This may not be surprising as NGAC reports to the Federal Geospatial Data Committee and the perspective of this white paper does indeed focus on the interests of the Federal role. However NGAC appears at least to be up front about its intentions when the document suggests that the metrics be used to identify deficiencies in spatial data infrastructures, and that could be a justification for “implementation of a national governance structure designed and funded to effectively preside over the coordination of all sectors ...in particular non-Federal stakeholders.” (Gorham et. al. 2009 p. 5)

GeoConnections Canada, the University of New Brunswick (UNB) and the Geospatial Industry Association of Canada (GIAC) addressed Web Mapping Services (WMS) aspect of the Canadian Geospatial Data Infrastructure (CGDI) specifically in their research project entitled “Advancing CGDI in Action” (UNB, 2010). The research provided many insights into the effectiveness of a specific technology used as a delivery method in sharing spatial information, Web Mapping Services, by testing and measuring the WMS of selected Canadian SDIs.

In a pre-test survey of administrators of these SDIs the exclusive and consistent reason cited for building and maintaining their Web Mapping Services was to fulfil a mandate to share their spatial information with the public or with other government departments. However, testing results indicated that despite these services being stable and responsive, few of them were receiving anywhere close to the volume of requests for which they were designed. This appears to be an example where adoption, not technology, is the barrier to information exchange.

2.4. Spatial Data Sharing – Beyond the Technical Boundaries

A 2008 White Paper, “Risks & Benefits of Spatial Data Sharing” by Pete Flagg, former General Manager of the Integrated Cadastral Information Society, looks at the legal, political issues related to risk regarding the sharing of spatial data. This

paper does not focus specifically on the Cadastre, or address the specifics of a Cadastre Information Model. However, it does cover a lot of the issues germane to the establishment of a collaborative framework from a policy and organisational perspective. Flagg discusses some of the key roadblocks to sharing spatial data, including cadastre, such as fear of misuse, liability and the balance of benefit versus risk. Perhaps most interesting is that while many of those referenced in this paper express the benefits of sharing spatial data, the paper includes a key comparison of perceived risks and benefits and makes the case that there are direct linkages between the two, and that there are few benefits that aren't associated with specific risks. Flagg does not indicate that sharing data is therefore not worth the risk, but rather suggests that any organisation proposing to do so should ensure they address, and communicate, the risk mitigation strategies that are to be undertaken.

Risk	Balancing / Related Benefit
Compromising Competitive Advantage	<ul style="list-style-type: none"> ○ Discover of new business relationships and new competitive opportunities.
Exposure of competence & capability	<ul style="list-style-type: none"> ○ Reduction of redundant effort ○ Comparable efficiencies made available
Compromised Security	<ul style="list-style-type: none"> ○ Enhanced public safety ○ Enhance response times of emergency responders
Compromised Interpretation	<ul style="list-style-type: none"> ○ Requirements for standardization and improved interpretation
Liability and Indemnity	<ul style="list-style-type: none"> ○ Reduced cost of legal administration ○ Clearly defined liability
Reliance on Data and Policy Control	<ul style="list-style-type: none"> ○ Improved operational efficiency ○ Greater access to more data ○ Data quality improvement
Compromised Revenue Generation	<ul style="list-style-type: none"> ○ Enhanced revenue from collected sources ○ Enhanced business opportunities through VAR interest in larger data sets ○ Enhanced revenue from greater "traffic"
Compromised Economic Development	<ul style="list-style-type: none"> ○ Discovery of new relationships between business and demographic phenomena
Contravention of FOIPA	<ul style="list-style-type: none"> ○ Transparency and convenience of data access

Table 1. Benefits and Comparative Risks of Spatial Data Sharing (Flagg, 2008 p. 16)

Flagg concludes that the risks should not be ignored, nor should they become a roadblock preventing sharing of spatial information such as cadastre. An important step is an open and transparent understanding of the benefits and risks enabling informed decisions and a conscious undertaking of measured risk in order to realize specific benefits. Still, it is challenging to convince individual organisations to take on an individual risk which leads to a shared benefit.

2.5. Spatial Information Exchange – A Knowledge Management Challenge

Flagg's paper directly confronts the human interaction challenges to be resolved when encouraging data sharing. Without participation, there is little use for an

enabling underlying cadastre information model. But how would one go about transforming the dynamic from a individuals with specific self interest to one where a truly collaborative behaviors emerge.

In the 2002 publication “Cultivating Communities of Practice: A Guide to Managing Knowledge authors Wenger, McDermott and Snyder explore what constitutes a Community of Practice (COP), and why and how these communities provide value. They also look at how to plan and institute a COP and the lifecycle of a COP. In addition they review some of the challenges and downsides of a Community of Practice.

They define a Community of Practice as “groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis” (Wenger, McDermott, Snyder, 2002). The roots of COPs are traced back to trade guilds and early apprenticeships. Although many examples in the text refer to intra-organisational implementations, such as the example of Chrysler’s resurgence in the late nineteen eighties, the authors point out that where the members share a common purpose these Communities of Practice often span multiple organisations.

It is explained that a community must be flexible in its design to allow for growth and “evolution” over time. A rigid framework may not adapt to unanticipated changes to the needs and priorities of its members. In addition a healthy community not only accommodates, but encourages external interaction. This helps to avoid stagnation and group-think, but more importantly, a healthy community, according to this text, sees itself as stewards of the collected and created knowledge and making that knowledge available to the broader community is an important aspect of preserving and building upon that knowledge.

Communities of Practice should also accommodate various levels of participation. It is acknowledged that not all members will be equally engaged at any one time. There will be a small core group as well as a larger group of active contributors while the largest group of all will be observers or ‘lurkers’. Each role is seen as valid and the community will be more effective if it allows for this, as many active contributors may have begun their involvement tentatively, as observers. Finally, there are those who are interested ‘neighbors’ who are not part of the COP, but who have a role to play.

Other interesting characteristics of an effective Community of Practice include the provision of both public and private ‘spaces’ for interaction. These spaces may be virtual environments but they often also include face to face meetings or even social events.

Ultimately, Communities of Practice must focus on value. Purpose is a defining characteristic of a Community of Practice. The value can, and perhaps should, however, be allowed develop and change over time; the result of an emergent strategy.

Another important requirement for a healthy COP is maintaining a balance between the familiar and the new. Driving every activity into unbroken ground may be exciting, but it is also likely to lead to chaos and reduce the value provided. On the other hand, in order to move forward, creating new knowledge and providing value, the community must do more than simply work within a static framework.

When the authors address the early stages of a community's formation they stress that shortly after the group coalesces they should strive to deliver 'immediate value' and build a case for membership, i.e. create a value proposition.

As the community matures one of the things it needs to tackle is defining its role, its boundaries, in terms of other communities, groups, firms or organisations. Is it competing with an existing construct, and if so is this a deliberate strategy? Are there overlaps or gaps which suggest where additional or new value could be found for the community members?

Meanwhile, the community must work to remain open and transparent, working to recruit new members, as well as identifying and developing new leadership.

In discussing some of the challenges facing distributed communities, the authors note that those communities which span several organisations must pay particular attention to issues of Intellectual Property as well as developing priorities for the community among a stakeholder group that may have different and even competing individual priorities. Regarding this latter point, the authors suggest that distributed communities often must spend additional time up front in creating agreement. It may be easy to get token agreement but a true lack of consensus will often manifest itself when different members or member agencies are reluctant to commit time and resources

In "Common Knowledge: How Companies Thrive by Sharing What They Know" (2000) author Nancy Dixon looks at examples of organisations who have overcome many of the common hurdles to sharing knowledge.

Dixon explains many of the principles, some of which are counter-intuitive, that can enable organisations to maximize the knowledge resources at their disposal while growing additional knowledge in the process. One of the primary challenges of Knowledge Management is that much valuable information is tacit and is not easily catalogued and published. She asserts that a willingness to share is generally not the roadblock (Dixon, 2000, p. 6) but rather the lack of

effective mechanisms to enable knowledge transfer. Dixon goes on to discuss some of the types of knowledge transfer.

Serial transfer is perhaps the most formal method, a prime example being the U.S. Army's After Action Review (AAR), where situations are discussed thoroughly and methodically to uncover learning that might not otherwise surface or be disseminated (Dixon, 2000 p. 37). One of the barriers in sharing knowledge in this, and in the other methods, is a concern over consequence. If participants are unsure how their shared knowledge will be used or interpreted when passed along to third parties there may be a reluctance to share. The Army's AAR procedures have a couple of characteristics designed to address that reluctance. First, they do not forward written reports, and there are no recriminations. The information is shared as a learning opportunity, not to place blame.

Near transfer is defined as sharing information from one work group to another where that information is highly relevant to the receiving group. The term near transfer meaning that there is little distance in the context or applicability of the knowledge between groups. Separate work groups performing similar tasks under similar conditions would benefit from engaging in near transfer of knowledge, particularly if the receiving team had the expertise to absorb and implement that shared knowledge (Dixon, 2000, p. 65)

Far transfer is described as sharing knowledge, more often reciprocally, between groups with similar purposes but operating in different organisational or political contexts (Dixon, 2000, p. 89).

Strategic Transfer describes an organisations infrastructure for the purposeful creation of knowledge assets. It generally includes the creation of activities as well as enabling databases and applications designed to support this effort. Whereas other transfer methods may form from the ground up, or across organisational boundaries, Strategic Transfers are those which originate with senior management (Dixon, 2000, p. 105).

Dixon identifies the fifth type of knowledge transfer as Expert Transfer, which is perhaps the most common (Dixon, 2000. p. 127). It often includes an IT based mechanism to enable exchange and development of knowledge among a specific group of professionals.

For a group involved in the development and management of a cadastre information model, several of the knowledge transfer types may be relevant. For the geospatial technical resources tasked with the practicalities of exchanging spatial information, an Expert Transfer system may be beneficial as a means to communicate, share and develop solutions to a complex technical challenge.

Far transfer is a likely model for the general sharing of information between the parties, as they are involved in a common mission, the enablement of sharing spatial information, specifically cadastre information, yet each organisation has their own political and organisational context. Such a model may be useful for coming to a common understanding of the challenges as well as providing a forum for the ongoing resolution of those challenges enabling the establishment of the cadastre information model.

Suppliers of cadastre information realize their information will be used by others as a foundational data set. A serial transfer method of some kind could be a useful instrument to ensure that the tacit as well as explicit 'meta data', or information about their information, is shared along with the data itself. Of course these knowledge transfers would be as beneficial for a regulated as much as for a non-regulated consortium. It may be something more effectively implemented, however, in a non-regulated environment. Knowledge Management (KM) guru Dave Snowden is adamant that "knowledge can only be volunteered, it cannot be conscripted" (Snowden, 2008). At the least it is reasonable to consider that information would more easily be volunteered within the context of a volunteer organisation and that some might be suspicious of doing so through a legislated mechanism.

2.6. Collaboration from a Geospatial Perspective

In the 2005 GITA white paper, "Geospatially Enabling Community Collaboration: The GECCo Pilot Project Series" (GITA, 2005), the educational society proposes looks at some of these same Knowledge Management issues more specifically from the perspective of geospatial information exchange and cadastre information models. GITA explores its GECCo model for initiating and sustaining collaboration for the purposes of spatial data exchange.

Given that protection of critical infrastructure and emergency response requires a coordinated prepared response, how should communities go about ensuring that the appropriate relationships and processes are in place before an emergency is upon them?

Issues that must be worked out before such a framework can be functioning efficiently include:

- intra and inter organisational collaboration.
- practices and guidelines
- Information access and exchange
- Interoperability and enterprise architecture, and
- Data and technology requirements

GITA proposes that the process must start somewhere, and ideally that is facilitated Pilot Program to kick-start the relationship building as well as current

and desired state assessment, leading to preliminary gap analysis and action planning.

Commonly encountered barriers identified in initial workshops across the country include only a few technical issues such as data formats. Most barriers are related to data, process or policy. Liability, licensing and legal issues concern many, as does data quality and privacy protection.

Findings of initial Pilot Program workshops identify that collaboration and support is required to develop frameworks for data sharing standards and legal data sharing agreements as well as to develop an appropriate funding model.

Data and IT standards and data model issues need to be addressed. It is agreed that the key enabler for effective sharing of spatial data is a shared, single cadastre, providing a framework for the sharing of other data.

Some of the themes address Emergency Response issues specifically, such as the establishment of mobile and map production practices.

The paper identifies keys to success derived from initial pilots. Establishing a dedicated and consistent team and employing ongoing facilitation are keys to success as is achieving consensus on operating procedures, roles and responsibilities.

The most important factor, identified as the key to success is collaboration. If an geospatial data sharing community is to succeed, there must be a commitment to collaboration at the local level as well as with supporting State and Federal agencies.

2.7. A Leadership Challenge

The GITA findings are consistent in that there is a broad appetite for a sustained, effective exchange of spatial information through the establishment of a common cadastre information model. Unfortunately a lack of leadership results in little progress after the initial workshops are held (Austin, 2010).

Leadership

In “The Leadership Challenge” Kouzes & Posner provide a compelling argument that the quality and type of leadership provided is a critical factor in getting the most out of people. Leadership Challenge provides insights into just what constitutes that kind of leadership, particularly leadership that does not depend upon positional authority (Kouzes & Posner, 2002, p. 384). Their book begins by explaining the five practices of exemplary leadership (Kouzes, Posner, 2002 p. 13):

- ◆ Model the Way
- ◆ Inspire a Shared Vision
- ◆ Challenge the Process
- ◆ Enable Others to Act
- ◆ Encourage the Heart

They follow with the argument that behind these practices, at the foundation of effective leadership is credibility. Whoever is leading must possess and demonstrate credibility. They present research that shows the characteristic people consistently rank as most important in a leader is honesty (p. 25).

One of their foundational propositions is that people are far more likely to continue to work towards a goal in which they believe, to which they are committed, than one that is externally imposed (Kouzes, Posner, 2002, p. 112). They assert that self motivation is far more effective at continued performance than external reward and punishments.

Despite acknowledging this self motivation they are not suggesting leadership is unimportant. Leadership, they argue is indeed critically important, but rather than dictating, their objective is to build a shared vision that a diverse group can collectively support (p. 78). Kouzes and Posner thoroughly explore the what and how of developing shared values (Kouzes & Posner, 2002, p. 78) and enlisting voluntary assistance (Kouzes, Posner, 2002, p. 141).

Operations

Beyond the inspirational aspect of leadership, day to day operations management competency will be required of any organisation attempting to facilitate the exchange of information between different stakeholder groups.

The heart of an effective collaborative model will depend upon how well it operates. With a large number of stakeholders involved there is additional risk to operations that there will be competing priorities or a lack of attention (i.e. governance) due to it being 'external' to the main operations of any one of the individual companies. Slack, Chambers and Johnston's text provides a means of reviewing the basic operating structure of candidate models for cadastral information management. In particular the Quality Control & Processing discusses how to establish, or evaluate processes (Slack & Johnston, 2007, p. 537). The text argues that of equal importance is the fundamental design of the products or services being delivered. Chapter five of Operations Management provides guidance on how to properly design products (Slack & Johnston, 2007, p. 119). A possible evaluative or comparative tool from this text is the Quality function deployment (QFD) matrix for an information system product. In the context of this project, such an IS product would be the cadastre information model.

The QFD methodology is just one example of a possible technique found within Slack and Johnston's text, but with a diverse group of stakeholders, there would be benefit in leveraging some methodology to ensure a comprehensive and inclusive process of gathering input in support of setting operational objectives and measuring progress against those objectives. QFD is just one tool that helps management link operations design logically to stakeholders' requirements (Hauser, Clausing, 1988 p. 77)

2.8. Spatial Data Exchange – An IT Challenge

For the purposes of this study on spatial cadastre information models in a collaborative environment it is useful to take a brief look at how the Information Technology environment is being, or could be, implemented to facilitate that collaboration. Some of the basic models discussed in the Turban, Leidner, McLean & Wetherbe's text "IT for Management: Transforming Organisations in the Digital Economy" (Turban et. al. 2008) provide a framework for discussing where inter-organisational boundaries most appropriately fit.

Any organisation that purposed itself to enable a cadastre information model would find value chain management principles relevant. The gathering of data and blending into a single seamless 'fabric' would be the intervening business with those creating the individual components of cadastre, such as local governments functioning essentially as suppliers, while those wishing to collaborate based on the cadastre model would function as consumers of the product; the assembled cadastre. With geospatial information management being primarily an IT enabled activity, any organisation functioning as a 'broker' of cadastre information would logically be looking to optimize this value chain through efficient management of IT workflows and infrastructure.

The text places information systems into a hierarchy, with personal and productivity systems at the lowest, or simplest, level. Further up are transaction processing systems, functional and management information systems, and eventually enterprise systems. Still further up this complexity ladder are interorganisational systems (Turban et. al. 2008 p. 43). One could expect, therefore that an interorganisational collaborative whose primary activity would be IT enabled information management would therefore need to create and maintain an information system of considerable complexity. This is something to consider, whether a voluntary organisation, lacking legislative backing, could sustain such a complex information system.

Relevant models discussed in the text include the Porter supply chain (Turban et. al. 2008 p. 37) pertaining to the delivery model for moving information from numerous local governments into a single data store, and back out to users of the consolidated parcel fabric, the Knowledge Management Cycle (Turban et. al. 2008 p. 394) as it relates to linking explicit knowledge such as the cadastre

geography and the tacit knowledge such as the meta-data relating the accuracy, currency and pedigree of the parcels. Additionally some of the discussion about the issue of data quality will benefit from reference to the chapter on data management and data quality (Turban et. al. 2008 p. 83)

The text cautions that data quality can be challenging enough where lack of clarity and consensus regarding ownership and responsibility create problems within an organisation. A lack of clear and implemented policies often exacerbates the issues. Additional challenges around data management include data privacy, and the basic matter of enabling convenient enterprise wide access when dealing with years of legacy data, much of which exists in hard copy format. How much more so would issues such as these need to be addressed carefully and thoroughly if an interorganisational effort to collaborate on data sharing is to succeed.

Turban et al do discuss the options available to address these kinds of challenges, all of which require considerable discipline and IT expertise, which again presents a challenge for any volunteer organisation that working without government legislation, may also be operating substantially without government funding.

Interestingly, this treatise on IT also touches on the Knowledge Management issue. The authors discuss the importance of sharing tacit knowledge, knowledge that is not easily codified, categorized and shared. While a cadastre information model primarily concerns itself with the exchange of very explicit and defined information, data in fact, some of the reviewed literature on Spatial Data Infrastructures does acknowledge that a major hindrance is often the lack of understanding, or trust, that different organisations can place on data supplied by other organisations; data they know little about.

Dr. Robert Austin speaks to this issue as well in his 2010 presentation to the Geospatial Information & Technology Association's GECCo (Geospatially Enabling Community Collaboration) workshop in Phoenix Arizona he reviews lessons learned from an earlier GECCo in Tampa, Florida, in which he cites usability as a major challenge not because data isn't made available, but because it isn't understood (Austin, 2010 p. 20). From an Emergency Response perspective, it is as important to have the people coming together as much as to have their data as those who provide the information are the best ones to help interpret it, and to give it the appropriate context. This too may be something those attempting to compile spatial information from multiple sources could consider to their benefit.

Given the information covered in the preceding literature review it is possible to present the hypothesis for this research paper.

3. Hypothesis

The hypothesis of this research paper is that an effective cadastral information model can be implemented across multiple jurisdictions working within a collaborative (non-legislated) environment. The research design is intended to guide users through the process of supporting or rejecting the hypothesis. This will be followed by a discussion of the research findings and a conclusion based on those findings.

4. Research Design

Research was conducted through a review of published information on the issue of spatial data sharing, cadastre information models, and spatial standards adoption. I will draw on publications by those involved in the implementation of cadastral information models and data sharing. Given the recent advances in spatial technologies that enable such data sharing most relevant publications have come from the past 10 years.

Principles of Knowledge Management and Leadership relating to the dynamics involved in sharing information effectively have also been incorporated. Some basic principles of Operations and IT management are reviewed as well given their roles in what amounts to a complex organisational challenge to create an ongoing flow of technical data between numerous and diverse organisations.

This paper proposes to answer the question “Can an effective cadastral information model be implemented across multiple jurisdictions working within a collaborative (non-legislated) environment?” with a particular focus on Canada but referencing relevant international initiatives.

For the purpose of this study a collaborative environment means one in which participation is voluntary, where key stakeholders are not obliged to participate through legislation or licensing requirements imposed by a government or professional licensing association, but rather do so out in response to a perceived benefit.

Jurisdiction refers to the geographical area of interest of governments having authority in the area of spatial data exchange. Almost exclusively the community of stakeholders in a multijurisdictional area is the extent of the highest level of government involved. Most commonly it is a provincial or state jurisdiction, and at times the jurisdiction is federal. These areas are multi-jurisdictional because within a higher level of government there will be multiple local governmental stakeholders who have jurisdiction over discrete portions of the overall area. The term jurisdiction is used because it is the presence of jurisdiction that is most often the catalyst for the exchange of spatial information. Utilities, for example, must apply for permission to construct infrastructure in the public rights of way

within different municipal jurisdictions, or perhaps on lands under the jurisdiction of the provinces or states such as on crown lands or highway rights of way.

There are many examples of cadastre data models that cover a single jurisdiction. Municipalities often develop cadastre models that others work from, but at that level the challenge of establishing a collaborative framework is much smaller as a single cadastre model can be defined by one jurisdiction to cover the area, so the need to agree on a single model between jurisdictions is not present.

Sharing spatial information across government agencies and between utilities and governments is an important component of creating an effective cadastral information system because it presents challenges that are not simply technical in nature. The ability to develop a committed consensus for something that goes beyond a lowest-common-denominator solution is no small challenge. Anything that is sufficiently complex and sophisticated enough to provide real value to the stakeholder community will no doubt subject members of that community to various levels of discomfort. There will be a requirement to negotiate that is not present in a legislated environment where only the legislator need be convinced that the solution meets their needs. (Those needs may have apparent aspects of community concern if that legislative body has need of cooperation in other matters from the stakeholder community, or if the solution could potentially impact the potential future viability of the legislative body.)

Cadastre information models developed within legislative frameworks will be reviewed as far as required to develop a framework for defining the characteristics of a cadastre framework. It is the 'what' component of the model. Technical data formats, software applications or map projection issues are not the focus of this study.

Of broader interest and the focus of this research project is the process model, the 'how' component, of which there are several aspects. This study will determine the challenges faced by stakeholder organisations in coming together, working together, and in determining suitable supporting business models that provides a sustainable framework for a shared cadastre framework.

It is noted that existing examples of cadastre information models, SDIs and spatial data sharing communities have developed within different, specific, environments, and may be solving somewhat different problems. This makes comparison a challenge.

In order to define what constitutes an effective cadastre information model, the study will address the basic characteristics of such a model as reaching agreement on these characteristics is likely to be a relevant source of conflict between stakeholders.

5. Discussion

5.1. Developing Support for a Cadastre Information Model

We have seen that there is often reticence on the part of firms to take on individual risk in exchange for a shared benefit. However, according to Kouzes and Posner (2002, p. 242) managers of these firms would do well to keep in mind that collaboration is a key to improving individual performance, and that “It won’t be the ability to fiercely compete but the ability to lovingly cooperate that will determine success.” Their research indicates that cooperation is more likely to be sustained in an environment where participants are self-motivated, rather than one in which external pressures create resistance and resentment (Kouzes, Posner, 2002 p. 112). Snowden agrees in essence when he declares that “knowledge can only be volunteered, it cannot be conscripted” (Snowden, 2008). Certainly few who have filed their tax returns would argue that information cannot be conscripted, but by speaking specifically of knowledge Snowden seems to be indicating that conscription will result in something less than the richness of information sharing that can be achieved voluntarily. To that end there is more to be gained on a volunteer basis, if that is, one can find volunteers.

In Ontario, the provincial government led the implementation of a cadastre model through a Private Public Partnership with Teranet Incorporated. Even in a case where legislation and provincial funding were the primary enablers, the challenge of building consensus was acknowledged. Teranet noted that a consensus building activity “typically results in defensive postures on the part of those institutions, organisations and individuals which are directly affected” (Teranet, 2001).

From a risk management perspective, it is easier to convince a manager to view compliance with legislation as a risk mitigation investment. After all, there is generally a defined and tangible penalty that can be ascribed to non-compliance. The ROI equation is explicit. In a collaborative environment, however, compliance can be seen as asking for a favor. First, it is so simply because compliance is being requested. Secondly, while the cost in effort may be minimal or significant, it is visible. There is an impact to the organisation internally. Yet any shared benefit may be less tangible and more challenging to ascribe concrete value. Often the benefits are ‘strategic’ in nature, such as increased collaboration, improved external relations or vaguely quantified ‘increased efficiencies’ (Flagg, 2008). From this perspective securing cooperation across a broad variety of constituents without the benefit of a legislative framework which compels participation in and contribution to a cadastre information model seems a daunting task.

Some will volunteer. The law of large numbers would seem to assure us that in developing a multi jurisdictional cadastre information model a certain number of

parties will indeed volunteer. The same principle, however, would also suggest that left to voluntary participation some also will choose not to volunteer.

5.2. Collaboration – The Human Component of Data Sharing

For some spatial data sharing activities partial compliance may be adequate. Let those who wish to collaborate do so. For the purposes of a cadastre information model however, completeness is repeatedly cited as a key indicator of success. Therefore full participation eventually becomes necessary. Critics of a non legislated framework point to this weakness as the fatal flaw; that participants cannot be assured that the entire community of participants will agree to the terms of the framework and thus the model will be incomplete. Indeed completeness is seen as a key measure of a spatial data set's effectiveness. (Obermeyer, Pinto, 2008, p.84)

Utilities have perhaps the greatest interest in making use of a seamless multijurisdictional cadastre fabric (Flagg, 2008, p. 12), yet conversely they are the most likely to express reluctance regarding data sharing themselves, citing data security concerns (President's Commission on Critical Infrastructure Protection, 1997, p. 28). Interestingly the President's Commission on Critical Infrastructure Protection found that the single most critical need was information sharing (1997, p. 21). While utilities are not providers of cadastre, their broad geographical operating 'footprint' makes them the primary beneficiaries of a cadastre information model. Therefore their participation is a key component of success. In a legislated solutions such as in Alberta with Spatial Data Warehouse and in Ontario with Teranet, commercial providers supply utilities with a convenient pay for use access to the needed cadastre information. In a collaborative effort, however, utilities have a unique role to play.

Utilities are supportive of the need for a cadastre model. It is a much better option than each of them individually sourcing and compiling the data themselves. However, paying for a product is one thing. Paying for the long term development of a potential data source is quite another. They have a defined business need to manage their infrastructure across local government jurisdictions, but that is an immediate need which can generate impatience with a collaborative approach that has a long time horizon for delivery (Flagg, 2008, p.12)

5.3. Interoperability – The Technical Component of Data Sharing

Geospatial Interoperability, can exist in different, specific, levels; technological, syntactic and semantic levels according to ISO standards (Tolk 2003, Turnitsa and Tolk 2006). From the perspectives of those wishing to exchange spatial information, however, the objective is simply to be able to do so easily and consistently, and to do so requires all these levels to be addressed, and more. The experience of the Integrated Cadastral Information Society indicates that the

most important and foundational level of interoperability is the relationship level (Flagg, 2008). This position is reinforced by GITA's GECCo workshops around the United States. The Tampa GECCo stakeholders' experience was typical. Of the 37 barriers to spatial data exchange they identified, only 7 of 37 were in any manner technological (Shannon, 2009).

One of the challenges with established cadastre models is that even once created, their effectiveness is extremely limited until they are embraced and adopted (Moeller, Shannon, 2009). The embrace must precede adoption, and an embrace requires trust. Although Teranet in Ontario, and the Spatial Data Warehouse in Ontario were implemented over a few years, the adoption rate began and remained low. Legislation may have hastened the creation of the technical and organisational structure; however it did nothing to develop the relationships, the trust.

From the perspective of those who need to use the kind of multijurisdictional land base delivered by a cadastre data model the efficacy legislation affords in the delivery of a completed product is important. The sooner companies and local governments can commit to a single set of framework data, that sooner it can begin build workflows and spatial information to that model. Some organisations operate across multiple jurisdictions, and therefore would benefit from a functioning cadastre information mode, yet they may be almost exclusively with internal information exchange. For such entities adoption by others may not be a critical factor. For others, however, the usefulness of that framework remains limited until it becomes the de facto standard, the kind of interoperability exchange 'port' that allows transfer of spatial information products between entities. For those with critical intra-organisation data interchange requirements, the additional time that appears to be required to create a collaborative model, to develop the relationship level of interoperability may be warranted.

5.4. Leadership – Creating a Collaborative Environment

By definition the significant differentiator between a legislated versus collaborative cadastre information model is voluntary participation. If a collaborative model is to be successful, it is reasonable to conclude that strong leadership in an inter-organisational context will be necessary.

Committed partners in a collaborate cadastre information model must be self motivated, but according to Kousez and Posner leadership is also critically important in order to lead development of a shared vision that a diverse group can collectively support (2002, p.78). This would seem particularly challenging, and therefore all the more important when working in an interorganisational situation. The "vacuum of leadership" that has hindered the implementation of the Core Cadastre Data Model in Europe would seem to confirm the importance of leadership in this context (Lemmen et. al. 2005).

An effective model requires parties with different values and objectives to come together for a common purpose (Kouzes, Posner, 2002, p. 141).

5.5. Cadastre Models in Action

The shipping container industry provides a vivid example of interoperability. Incredible efficiencies have been realised through the adoption of a standardised format, the shipping container, for the exchange of goods. At each moment of interchange between points of origin and destination a packet of goods can be moved from one transportation mode to another without reformatting or repackaging. This allows for different network standards to coexist, as long as there is a defined interchange point to make the transfer, such as a port. A cadastre information model can function as a kind of geospatial interchange point to provide a more efficient exchange of geospatial information products between organisations with different local spatial infrastructures.

Cadastre Models vary in their scope. Some are quite basic and others are quite sophisticated, detailed and advanced. There are also many different levels of implementation. Some models remain entirely theoretical, while others have been in an operational or sustainment mode for over a decade.

Canada, as in most developed countries, there are cadastre models in place (NRC, 2010). Provinces such as Alberta, Saskatchewan, Ontario and Quebec have substantially complete cadastre data sets being maintained, but their models are different. Alberta's Spatial Data Warehouse is a basic data set with line work but no significant data attribution (AltaLIS, 2010). In Saskatchewan the Information Services Corporation shares cadastre with a limited data model, but they also function as a Spatial Data Infrastructure, much like GeoBC, in providing the ability search for and about a large variety of other spatial data sets (ISC, 2010).

5.6. The Many Faces of Regulation

So what is a regulated Cadastre Information Model? In some cases it can be legislation that compels use of a certain method or standard during a particular transaction. For example, Alberta's Spatial Data Warehouse (SDW) requires submissions of plans to be provided in a particular format along with a specific fee, in this case \$10 per parcel (GoA), that ensures a common format as well as funding to sustain the maintenance of a common cadastre. Additionally the legislation requires submissions in specific formats and a set of metadata to allow for integration of the plan submission into the SDW cadastre model.

In other cases, regulation may be an exclusive contract to maintain and vend a multijurisdictional cadastre, such as in Ontario, Canada. Teranet was formed in 1991 as a Public Private partnership in order to enable eGovernment (Teranet 2009). Government support that attended the legislation meant that the Teranet

cadastre information model could be built with one billion dollars in funding (Tarle, 2001).

Government support in efforts to establish cadastre information models are not necessarily always in the form of legislation. Often support is provided through the establishment of policies (France), strategies (New Zealand) or investment initiatives (USA) (GIAC, 2009).

5.7. Possibilities: The Integrated Cadastral Information Society

The billion dollar Teranet budget is in stark contrast to the ICIS, which has operated under an annual budget ranging of less than a million dollars annually, including the provisioning of annual operations.

While the ICIS cadastre data model is not yet fully completed, since its inception in 2001 the society has secured over 1.8 million parcels and secured over 200 data sharing agreements with utilities, local, provincial and regional governments and agencies, and First Nations members (ICIS, 2010). Despite ICIS still being on the road to its objective of fully populating a single cadastre for the Province of British Columbia, ICIS has experienced success. According to Myron Doherty of ESRI Canada, "ICIS has demonstrated remarkable leadership by developing an innovative approach to data sharing that is unique in this country" (Logan 2010). While it works towards its ultimate objective in terms of its cadastre model, it has established and continues to strengthen those key elements that underpin and ensure their ultimate success by operationalising its data sharing activities through its BC Spatial and Address BC programs (ICIS, 2010).

ICIS Executive Director suggests two keys to their success. The first is to "stick to their knitting" and staying focused on their strategic objectives (Logan, 2010). With a diverse group representing over 200 individual organisations there are constant temptations to pursue various opportunities. However, by validating operational activities against the society's four key themes of "demonstrating value, sustaining the society, growing collaboration and communicating" the society moves steadily forward (Logan, 2010). This aligns with McGuire and Smith's (2008) assertions that geospatial investment must tie directly back to articulated business objectives. That ICIS has been able to achieve consensus from its membership on such business objectives suggests they have paid attention to their second key to success.

Logan (2010) claims that the second key to the Integrated Cadastre Information Society's success has been its patience in listening. An engaged board, combined with a membership and communications strategy that includes significant investment in workshops held throughout the province has helped ICIS to develop an engaged membership. The reason that spatial data sharing activity, the fundamental purpose of forming the society in the first place, has increased, is human interaction, two way interaction and spontaneity made

possible by the face to face local workshops and board meetings. This seems likely given that the preponderance of literature on the topic list development of trust and consensus as a major barrier to collaboration, requiring significant investment of time and effort (FGDC, 2008)(Moeller, Shannon, 2009)(Turban et. al. 2008)

The main funding members of ICIS are the Province of BC, the BC Assessment Authority, BC Hydro & Power Authority, TELUS Communications, Shaw Communications, Terasen Gas and Spectra Energy. Local Governments and First Nations join at not cost in recognition of the value of their investment and the critical importance of their cadastre information (ICIS, 2010). Continued voluntary commitment at this level is evidence that the society members are engaged in knowledge sharing and are functioning as a Community of Practice (Dixon, 2000, p. 89).

6. Conclusion

There is an abundance of cadastre information models, including those defined by the broader ambitions characterized as a Spatial Data Infrastructure. Implemented and adopted models are fewer. Even in areas where regulatory or legislative incentives would be welcomed, this is seen as one enabler, not a substitute for the investment in relationship building. Legislation seems unlikely to spring spontaneously from government without a well coordinated appeal, such as the Geospatial Industry Association of Canada (GIAC) has been working to develop at a Federal level (GIAC, 2009). A collaborative cadastre information model can be successful in the absence of legislation. It would also appear that a truly successful model cannot be accomplished with the support of legislation in the absence of collaboration.

The literature indicates that in order to involve a majority of stakeholders in using a common cadastre model, then an investment relationship building is required. There were no examples uncovered where such efforts can be effectively short circuited. The examples studied showed that where a cadastre information model has been implemented on the strength of a single party or where mandated by legislation, then adoption of the model by the remainder of the community of potential users has lagged. While it is possible to independently put a model in place, such a model's effectiveness as an enabler of inter-al information exchange is going to be limited until it is adopted as a de-facto standard.

If there are private or public institutions who would be valuable participants in spatial information exchange, then it is recommended to include that party initially. Acknowledged and involvement in dialog is an enabler of engagement. If that engagement is delayed may serve only to increase any initial resistance to participation. An inclusive approach that takes time to understand stakeholder organisations' cultures (McDermott, R. O'Dell, C. 2001 p.82) may seem to slow

the initial process, but those involved in the ICIS indicate their upfront investment created an environment of trust and mutual respect that enabled them to secure over 200 voluntarily signed members.

The research here is limited by a paucity of fully functioning cadastre information models, particularly those based on a collaborative framework. The timelines of establishing such models take substantial amounts of time. Work on the issue often acknowledges the importance of engaging the community of stakeholders yet published material tends to focus exclusively on the technical work done in developing the standards and the Information Technology framework. While this is important and necessary work, whether the approach is voluntary or supported by legislation, those working on implementing cadastre information models are most often encounter the stiffest resistance to progress when they encounter the practical challenge of developing an engaged and collaborative community of stakeholders. The literature review also uncovered a wide variety of terminology and definitions of that terminology. Much is written about Spatial Data Infrastructures and those often have broad to extremely broad definitions of the kinds of information involved. Literature is less common that speaks specifically to the cadastre information model, apart from the various thematic layers of information which is overlaid upon that cadastre base framework. Some models speak to the technical definition of data while others describe their models in terms of work flows. Finally, the variety of Land Information Systems (LIS) that are found globally, and even across Canada, mean that approaches to implementing a cadastre information model based upon those LIS have varied.

A commonly documented challenge which has been encountered when attempting to make progress toward establishing a cadastre information model has been being able to articulate the value proposition to participating parties. Some studies have suggested the return on investment is significant (SIC, 2008 p.16) yet other than for federal, state and provincial governments; those research results have been vague about the specific tangible benefits of that investment smaller local governments or for utilities (SIC, 2008, p.23). Further research on the Return on Investment (ROI) of implemented cadastre information models could be a useful resource for providing a more compelling value proposition for those organisations who need to be committed participants in order for a cadastre information model to succeed as the ICIS experience seems to indicate that fairly modest monetary investment can lead to significant increased engagement (ICIS, 2010)(Logan, 2010). There may be no one specific way to succeed, but a resource of information that catalogues efforts that have succeeded beyond the design or implementation of a standard could also be a practical subject for more study. Such a study could prove most useful if it were to identify not only the data and software architecture used, but also on the organisational structure underpinning those models.

7. Appendix A: Characteristics of a cadastre information model

- ◆ Accuracy
 - Spatial accuracy has various components. In some data sets, location accuracy may be within centimeters of real world coordinates, or they may be off by hundreds of meters. A matrix of stakeholder requirements for accuracy will be used to determine required spatial accuracy based on use.
 - Another aspect of accuracy is the accuracy of attribute information. Spatial data sets include not only the geographic description of a property's location, but it must also contain information that describes its relation to other information through the use of key fields such as property IDs that link to assessment or ownership information. What is the required accuracy of such attribute information?
- ◆ Address data
 - Most stakeholders are concerned with the civic address of parcels. This study will again use a stakeholder matrix to determine what form and detail level of address information is required by users in order for the cadastre information model to be considered effective.
- ◆ Update timeliness
 - Some cadastre models are updated daily while some jurisdictions update theirs over a period of months. Again, a matrix will be used to determine what is required by stakeholders.
- ◆ Cost
 - Although acceptable cost is a subjective issue key issues of which stakeholders should pay and what they should be paying will be addressed in this research. Access to the cadastre data cannot be prohibitive to a stakeholder if it is to be effective.

8. Appendix B: Glossary

Cadastral

A Cadastral is a registered record of legal property boundaries and extents. A cadastral fabric is the mapping of contiguous parcels. A cadastral information model is the framework that determines how a cadastral fabric is depicted including the technical specifications and a description of the inputs from the various stakeholder groups such as surveyors, Land Title Authorities, Local and Provincial Governments and Assessment Authorities.

GIS

Geospatial Information System; computer applications that allow the input, editing and display of data using real-world location information (coordinates such as Latitude and Longitude) and attribution data th

Spatial Information

Spatial information describes the physical location of and the relative relationship between objects.

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