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ADOPTING THE CORE CADASTRAL DOMAIN MODEL (CCDM) WILL POSITIVELY CHANGE THE EFFECTIVENESS OF LAND INFORMATION INFRASTRUCTURE

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Abstract

Due to persisting challenges, the land market has become more sophisticated globally in the last two decades. This new realisation has sparked extensive awareness for the registration of land rights and responsibilities. Though, this could also be attributable largely to tenure insecurity in many parts of the world, land registration significantly contributes to economic development and investment. Various land registration systems have been designed in various countries to handle required data efficiently. The Core Cadastre Domain Model (CCDM) is been developed as an enhancement of Cadastre 2014 to increase data-sharing and authenticity beyond a cadastre. Though some antagonists argue that the CCDM may require huge financial investment, it is worth the investment to increase efficiency in land data management. CCDM will change information infrastructure positively – model is simple, flexible and extendable. It will improve information interoperability, organisational cooperation, cost recovery and stimulate investment in the long run. All stakeholders – governments, academicians, financial institutions, tax agencies, real estate firms and vibrant private sector – must put all hands on deck to realise the dreams of the CCDM.

Keywords

Cadastre, Cadastre 2014, Core Cadastre Domain Module (CCDM), Information Infrastructure, Spatial Data Infrastructure

1.0 Introduction

Land is, indeed, a very important resource. It remains the source of wealth and livelihood for humanity. There is also an increasing demand for land and the need for ownership security due to the following reasons: need for living space, density of the population, intensity of land use, potential of land, increase in demand for bio-fuels and land use conflicts. This changing trend has not only resulted in increasing demand for land, it has also sparked the awareness of people's rights, responsibilities and restrictions to land. In many parts of the world, changing trends of land demand has tremendously changed the face of land tenure. In most African countries, land has metamorphosed from a socio-communal commodity into a viable economic entity and is tradable. Land disputes, complex resolution procedures amidst high risks of losing property have also increased the desire to survey, record land transactions and register land rights. Currently, all encumbrances in land are registrable, though with different levels of legal effect. The social connotation that land is not a non-tradable commodity and should be freely available to everybody as a source of livelihood is almost non-existent in reality, though the concept still remains in most land-related literature, especially in Africa.

All over the world, different registration systems are designed to record land rights. These are designed to serve the needs of the particular countries. This assertion is also confirmed in the introductory remarks of van Oosterom *et al.* (2006):

> until today, most countries ... have developed their own cadastral system because there are supposed to be huge differences between the systems. The one operates deeds registration, the other title registration, some systems are centralized, and others decentralized. Some systems are based on a general boundaries approach, others on fixed boundaries. Some cadastres have a fiscal background, others a legal one.

Though, most of these land registration systems are still faced with lots of deficiencies, the system is under continuous growth, evolution and repositioning. In the scenario of land information building, the structure of the registration system is not of much relevance, but the intent. Different systems may be put in place to record land rights and responsibilities in every country, but the intent is security of tenure. A particular country's registration structure might appear inefficient; however, in as long as it meets her expectations, it cannot be disregarded. This, notwithstanding, it is also proper to note that the aim of every good land administration system is to reduce the risks associated with land transfer.

Land administration provides the background land information for structural change and transformation processes with regard to land tenure, land use and land valuation (GTZ, 1998). The UN Land Administration Guidelines (UN/ECE, 1996), as quoted by van Oosterom *et al.* (2006), van der Molen (2006) and Hensson (2008), define land administration as the:

> process of determining, recording and disseminating information on ownership, value and use of land when implementing land management policies.

This definition fully stresses on information as the basis for land administration. In the very modern context, land administration is not just about information or data determination, recording and dissemination, but also includes keeping this data as authentic as possible and frequently updating it to reflect current status.

Land registration has gone beyond just geographic data recording; it has also included all the identifiable relationships regulating people's relationship with land. In the instance, both formal and informal tenures are expected to be registered. Following these multi-registrable rights and interests in land, land administration agencies now have *"huge amounts of data, which, moreover, are of a very dynamic nature, and, on the other hand, requires a continuous maintenance process; the role of information technology is of strategic importance"* (van Oosterom *et al*., 2006, p. 3). In this regard, it is essential for governments and public institutions to promote good land management in order to build strong, authentic and up-to-date land information systems that will be effective and efficient as well as meet the needs of both her local and international clients.

The Core Cadastre Domain Model (CCDM) has increased the effectiveness of Information Infrastructure positively and presents ample opportunities for developing land administration systems to buy into the model concept. Every good land administration system is built around authentic and upgraded information system of land rights and ownership. Due to the complexities and volume of various data that need to be captured for land administration (formal or informal, customary or statutory, private or public, etc.), ICT has become immeasurably significant in land information infrastructure. Information Technology has penetrated all sectors of the world's economies, and land administration is not an exception. ICT has been used over the years to increase efficiency and effectiveness of data administration in the land

sector. In most European countries, such as Germany, Switzerland, Lithuania, Netherlands, among others, there is a complete shift from paper-based cadastres to digital cadastres. Even with that level of innovation, more improvements are still made regularly, making land administration service delivery more convenient. The use of ICT in land information capture involves the writing of various programmes and the development of softwares and models. Some of these models that have received much publicity are the popular Cadastre 2014 in Switzerland, the Core Cadastre Model in the Netherlands, the Social Domain Model, spearheaded by the GLTN-UNHabitat and Integrated Cadastral Management Model (ICMM) in Canada. Adopting the CCDM in the developing regions of the world within the broader concept of data integration is certain amidst known difficulties and deliberate antagonism from conservatives for positive change. The adoption will require high level cost for building the spatial infrastructure, developing the software, reforming institutions, reforming legislations and training manpower requirement base for land administration. Since nothing good comes easy, government will need to invest heavily in building efficient land information infrastructure data in order to reap the benefits.

This paper understudies the Cadastre 2014 as a basis for the design of the Core Cadastre Model. It is an assessment of how positively the Core Cadastre Model has improved on land Information Infrastructure in the land sector in some European countries and why this should be replicated in developing countries. Data for this paper is gathered from existing literature and, especially, country-level examples of how beneficial cadastre models have positively been improving the effectiveness of information infrastructure positively. Publications of previous authors on the CCDM are explored for the purposes of this discussion. For primary data, this paper also analysed responses and contributions from purposively sampled respondents to questions administered using the survey-monkey platform.

2.0 Building a Comprehensive Cadastre and Land Register

A comprehensive cadastre and an authentic register are the basis for every good and progressive land registration system. A cadastre is a general, systematic and up-to-date register containing information about the quantity (area), value and ownership of land parcels in a country (Dale, 1976). It is the systematic description of the land units within an area using maps that identify the location and boundaries of every unit and by records (Larrson, 1991). According to the Committee of Geodesy (1980), a cadastre may be defined as a record of interests in land, encompassing both the nature and extent of these interests. A cadastre is normally a parcel-based and up-to-date land information system containing a record of interests in land (e.g., rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests and ownership or control of those interests, and often, the value of the parcel and its improvements (FIG, 1995).

A cadastre, according to Henssen (2008), forms the basis of existing or expected legal situation of parcels which are represented on a large scale map with a parcel identifier. This identifier (parcel number) is used in a land register to indicate the legal object in a special, short and unambiguous manner. A cadastre may have both

descriptive and alpha-numeric part. In this context, a cadastre can be defined as methodically and systematically arranged public inventory of legal and other data concerning properties within a certain country or district, based on survey of boundaries of those properties (Henssen, 2008). The outlines of the property and the parcel identifier normally are shown on large-scale maps together with registers showing each separate property by nature, size, value and legal rights associated with the parcel.

There are various purposes for which a cadastre may be built, including for fiscal purposes, legal purposes, land use planning and other land administrative purposes. It enables sustainable development and environmental protection (FIG, 1995). The significance of cadastres has now grown beyond just taxation and legal purposes. Currently, due to the complexities and quantum of information required for a lot of societal needs (e.g., vegetation, agriculture, landscape, water, etc.), the concept of cadastre has, in the last decade, shifted to multipurpose cadastre systems. Hence, the concept of cadastre is portrayed in the Fig. 1 below. The cadastre

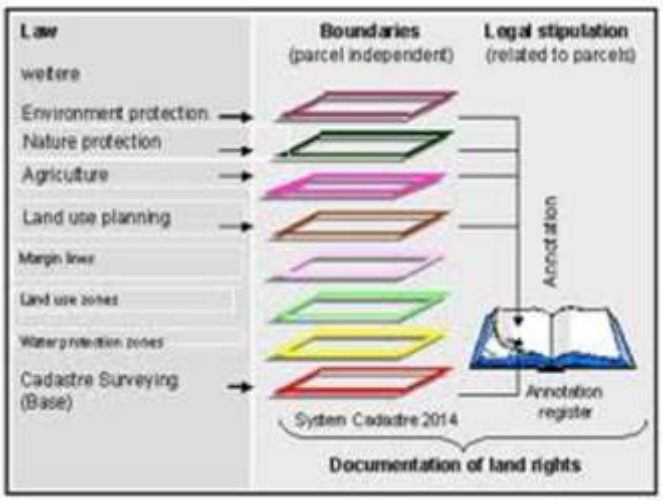


Fig. 1. The Land Information System of the Canton of Zürich, Switzerland

Source: Kaufmann, 2001

provides a spatial integrity and unique identification for land parcels and presents all the land uses in a single and comprehensible manner.

Though multipurpose cadastres have provided useful datasets for land administration, the system still had peculiar problems. For instance, according to Kaufman (2009), cadastre showed only private law matters restrictions, but public law is not shown and cadastres are not transparent to the land market. Cadastre also failed to link 'map' and 'register' efficiently. There were also difficulties in updating paper cadastres and information interoperability was almost impossible. Most cadastral systems were also overly centralised with no private sector participation and most systems were not cost recoverable. According to Williamson (2008, p. 8):

> paper cadastres alone also does not support integrated land management, or in providing critically important land information to enable the creation of a virtual environment, and, at a more practical level, e-government.

Following these shortfalls, there was a shift in trend towards digital cadastres, data automation and computerisation, public/private sector partnerships, capture of public legal obligations or restrictions or liabilities and self-financing cadastre systems. This period marked the emergence of the Cadastre 2014 in Switzerland and, subsequently, the concept was adopted in other countries in Europe.

3.0 Cadastre 2014 (1996-2014)

Following the failures of paper-based multipurpose cadastres, Cadastre 2014 was launched in Switzerland in 1996 to improve on land information. Cadastre 2014 presented a totally new approach to Cadastre in Europe. According to Kaufman (2009):

cadastre in the context of land business should be designed to acceptable principles, reliable, systematic, appropriate to needs/laws, adaptable to development and public.

Cadastre 2014 was designed to meet these requirements, such as show the complete legal situation of land, including public rights and restrictions; the separation between 'maps' and 'registers' to be abolished; cadastral mapping' to be dead and replaced with modelling; paper and pencil cadastre will be gone and Cadastre 2014 is to be highly privatized! Public and private sector are working closely together and Cadastre 2014 will be cost-recovering. These six (6) key principles as shown in Figure 2 below, indeed, sought to improve cadastre, not only in Switzerland, but any other part of the world, where these new ideas would be appreciated.

An important characteristic of Cadastre 2014 is that similar land objects are organised in independent layers. This is translated in the CCDM in different independent object classes, such as, Parcel and Building. All the classes of immovable properties or realties share the same characteristics: they are all related to persons through (all kinds of) rights, restriction and responsibilities (formal, informal, statutory, customary, legal, illegal, etc.). This person (man), right and parcel relationship is illustrated in Figures 3 and 4. They virtually give details and answer questions about who owns what, how it is held and where it is being held.

As land administration is dynamic, land and computer system administrators are also ever conscious of this situation and are always stand-

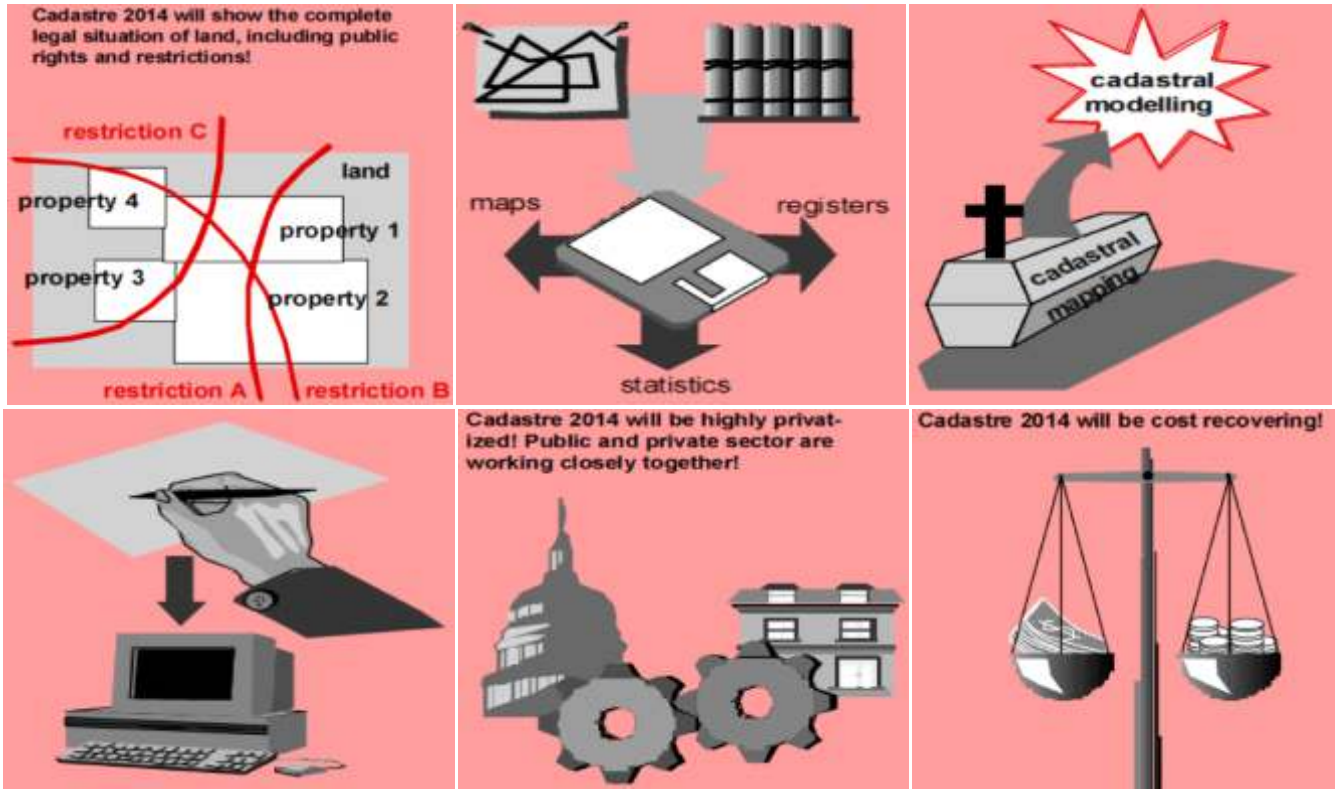
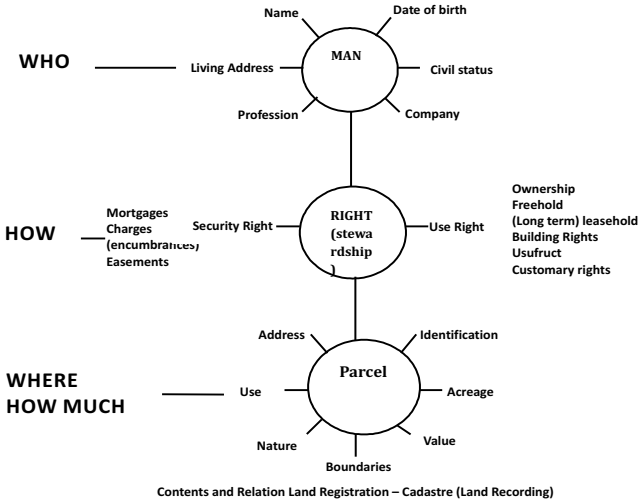


Fig. 2. The Diagrammatic illustration of key Principles of Cadastre 2014.

Source: Kaufman, 2009



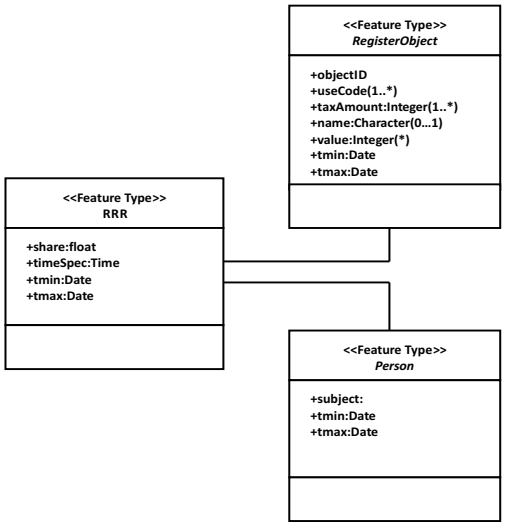


Fig. 3. Man-Right-Parcel Relationship **Fig. 4. Multipurpose Cadastre (Kaufmann, 2001)**

Source: Adopted from Henssen (2008) and Lemmen et al. (2005)

ing up to the challenges the system may pose. Following the significant progress being made with Cadastre 2014, to improve land administration in a more comprehensive manner, the CCDM was proposed as an enhancement, but following the same principles advocated earlier. This new model is more concerned with both the socio-technical arrangements of land information management. It is poised to improve inter-agency connection, reduce redundancy, increase information interoperability, increase information quality and authenticity.

The on-going discussion on the Core Cadastre Domain Model has, not only awakened land administration agencies to the growing realities of the land sector, but has increased the search for efficient means of land administration in many parts of the world. For example, as indicated by Sullivan (2006), the Surveyor General Branch of Canada has developed the Cadastral Data Model (CDM) for Integrated Cadastral Management (ICM). The fairly new CCDM supports about 23 property right regimes under 6 land registry systems in Canada. The overall objective of the ICM is to provide a flexible data model that allows the spatial representation of all rights on Canada Lands regardless of the property rights regime. Similar spatial data management systems can be replicated in Ghana to improve land administration. The potential offered by land information in a virtual world in spatially enabling government is so large; it is difficult to contemplate (Williamson, 2008, p. 8). These benefits can trickle down to Ghana, if the stakeholders involved will embrace and develop the necessary spatial infrastructure. Sullivan's illustration of the Canadian Integrated Cadastre Management System is illustrated in Figure 5.

4.0 Core Cadastre Domain Module (since 2003 and now called LADM)

The Core Cadastre Domain Module, since its 2009 revision, is now preferably called the Land Administration Domain Module. The concept however, still remains the same but with some

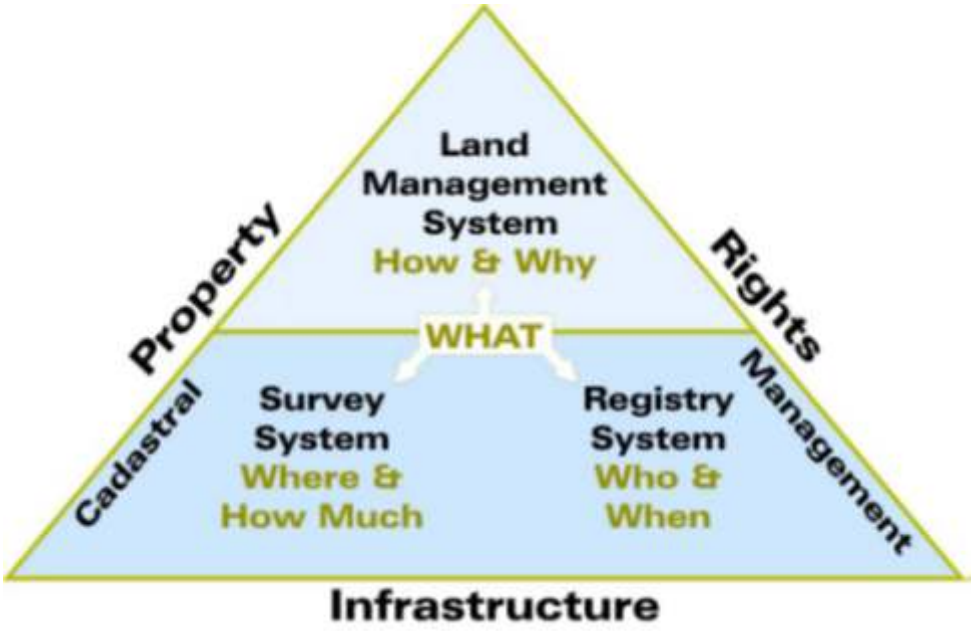


Fig. 5. Canadian Integrated Cadastral Management System

Source: Sullivan, 2006

design modifications. According to Lemmen *et al*. (2005), the standardized Core Cadastral Domain Model (CCDM), covering land registration and cadastre in a broad sense (multipurpose cadastre), will serve, at least, two important goals:

1. avoid reinventing and re-implementing the same functionality over and over again, but provide a extensible basis for efficient and effective cadastral system development based on a Model Driven Architecture (MDA), and
2. enable involved parties, both within one country and between different countries, to communicate, based on the shared ontology implied by the model.

Further, Lemmen *et al*. (*ibid*.) identified important conditions during the design of the model: it should cover the common aspects of cadastral registrations all over the world, should be based on the conceptual framework of Cadastre 2014, should follow the International Organisation for Standardization (ISO) and Open Geospatial Consortium (OGC) standards and, at the same time, the model should be as simple as possible in order to be useful in practise.

The Cadastre Domain Model has a lot of advantages to land information infrastructure and will impact on the system positively when implemented. The Model allows for data interoperability, it is user-friendly, since key parameters are described in text and with linear links (boxes and arrows) and it is evolving out of the Cadastre 2014 concept whose foundation is already grounded and its successes well known. Also, compared to other packages already in existence, the CCDM is being presented in comprehensive parts, maintains and develops packages independently, and has the possibility to use a package to implement one type of functionality. Furthermore, the CCDM is flexible and can be adapted to suit particular country or local conditions. It is likely that additional

attributes, operators, associations and, perhaps, even complete new classes are needed for a specific country. This can be done as extensions, but not to remove or rename parts (attributes, operations, associations and classes). Packages are, hence, extendable. The efficiency and workability of the CCDM can be confirmed in the statement of Lemmen *et al*. (2005, p. 14) that:

> the true intention is that, if one needs the type of functionality covered by a certain package, then this package should be the foundation and thereby avoiding reinventing (re-implementing) the wheel and making meaningful communications with others possible.

The heart of the model is based on the three classes: (1) RegisterObject (including all kinds of immovables and movables), (2) right, restriction, responsibility (RRR), and (3) Person (natural, non-natural and group). The model supports the temporal aspects of the involved classes and offers several levels of Parcel fuzziness: Parcel (full topology), SpaghettiParcel (only geometry), PointParcel (single point) and TextParcel (no coordinate, just a description) (Lemmen *et al.*, 2005). Besides the three well-known concepts, Parcel, Person and Right, at the class level the model also includes immovables, such as, Building and Other RegisterObject (geometry of easement, like a right of way, protected region, legal space around utility object, etc.) and the following concepts: SourceDocument, such as, SurveyDocument or LegalDocument (e.g., deed or title), Responsibilities, Restrictions (defined as Rights by other Person than the one having the ownership Right) and Mortgages. At the attribute level of the model, the following aspects are included: SalePrize, UseCode, TaxAmount, Interest, Ranking, Share, Measurements, QualityLabel, LegalSize, EstimatedSize, ComputedSize, TransformationParams, PointCode and several different date/times (*ibid.*).

5.0 Building a bigger Information Infrastructure for the CCDM

In the earlier histories of land administration, attention was only placed on land rights recognised by statutes in many countries. However, in recent times, the spectrum of registrable land rights has expanded to include indigenous, informal or customary rights. This is becoming necessary because, in most developing countries like Ghana, Uganda, Kenya, Zambia, etc. and even developed countries like Australia and Canada, customary and aboriginal land rights have gained a lot of significance. For example, about 80% of land in Ghana is in customary ownership. It is necessary to register these rights in order to give them the legal recognition. In principle, all land tenures are eligible for registration, with the purpose to assign ascertainable legal viability to the registered right. According to Williamson (2008) and van Oosterom *et al.* (2006, p. 3) and the functions of land administrators have also expanded beyond 'just handling only geographic information' as they represent a lawfully meaningful relationship amongst people, and between people and land. In the midst of all the changing dynamics of people and land relationships, land administration agencies are now dealing with huge amounts and variety of data. The use and users of land information have also increased significantly.

Within all these changing trends, there is the need to maintain authentic and updated datasets. This explains why the role of information technology is of strategic importance to keep database up to date. Information infrastructure is necessary to guarantee good performance of land administration systems and would, ultimately, meet the need for efficient data production, storage, delivery and maintenance. It is, therefore, not surprising that many organisations are now being compelled into ICT. There is a technology push:

internet, (geo)-databases, modelling standards, open systems, GIS, as well as a growing demand for new services, a market pull: e-governance, sustainable development, electronic conveyance, integration of public data and systems (van der Molen, 2004), as cited in Burmanje (2005, p11). Cadastral modelling is considered as a basic tool facilitating appropriate system development and re-engineering and, in addition, it forms the basis for meaningful communication between different (parts of the) systems. Inferring from the preceding statement, one can describe the development of the CCDM as a timely intervention to positioning land administration and information infrastructure in the midst of developing ICT.

6.0 Building CCDM needs Spatial Data Infrastructure

In most of the literature on Spatial Data Infrastructure (McDougall, 2006; Rajabifard & Williamson, 2001), SDI components are defined as data, people, standards, access and technology, policy and institutional arrangement. According to the "Spatial Data Infrastructure" (SDI), Cookbook (2008), the term, SDI, is used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of, and access to spatial data. According to GISL (2010), Land Information System (LIS) is defined in similar terms to SDI as:

> a tool for legal, administrative and economic decision-making, and an aid for planning and development which consists of a database containing spatially-referenced land-related data for a defined area and of procedures and techniques for the systematic collection, updating, processing and distribution of that data.

In this respect, SDIs provide the bases for spatial data discovery, evaluation and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and individuals.

Also, because of the multipurpose nature of SDI, many disciplines, organisations and specialists will have to work in concert. In the words of Feeney *et al*. (2001), as quoted by Paudyal and McDougall (2008), SDI is fundamentally about facilitation and coordination of the exchange and sharing of spatial data between stakeholders in the spatial data community. In simple terms, it is an enabling platform linking data producers, providers and value adders to data users (Williamson, 2008). SDI provides the interface through which spatial data producers/providers and spatial data users interact. The principal objective for developing SDI at any government or land administration level is to achieve better outcomes for the level through improved economic, social and environmental decision–making (Rajabifard *et al.*, 2001). SDIs have the potential to promote widespread use of the available spatial data sets, which are essential to optimize spatial technology support for decision-making processes (Feeney *et al*., 2001).

7.0 The State of Information Infrastructure in Ghana

The Core Cadastre Domain Model (CCDM) has evolved over the years, since its inception in 2003, with key concepts and parameters being revised annually. Quantitative and qualitative data for the study was gathered from questionnaires posted to 42 land administration professionals working in Ghana and middle-level professionals now studying abroad, through the SurveyMonkey online platform. Also, since the discussion on the CCDM is still largely centred in Europe, among key professional and academic institutions into land administration, such as,

FIG, ITC, TUM and Melbourne University, 11 other respondents were used to collect qualitative data for this study. From the data collected in Ghana, the CCDM only gained popularity among land professionals after 2007, though the model concept had been in existence since 2003. This could be attributable to the push at the time to popularize and standardise the model for global land administration using the FIG as its major springboard. In Ghana's case, the push to improve land information infrastructure globally in 2007 coincided with the running of the Phase I of the Land Administration Project (LAP), which ran from 2003 to 2010, with administrative, legislative and institutional reforms.

The survey responses gathered from the purposively sampled respondents is illustrated in Figures 6, 7, 8 and 9 below. From Figure 6, it was revealed that 44 respondents, representing 83% of the 53 respondents, confirmed knowledge about the CCDM, its origin, objectives and functionalities. A total of 9 respondents, representing 17%, were completely unaware of the debates surrounding the CCDM or the opportunities it presents to streamlining land management. From Figure 7, it was established that the knowledge about the CCDM peaked in 2007 when 33% of the respondent confirmed they had information about the model. In 2009, 9 respondent, representing 17%, had confirmed knowledge about the CCDM. However, since the proposition of the CCDM in 2003, some 25% of the respondents had already acquired the information. Another 25% confirmed they had knowledge of it in 2010. Though this level of responses did not establish the extent of knowledge on the CCDM, it is assumed that all respondents have basic knowledge about the nature of the model and the purposes it is targeting.

Notwithstanding the fact that the CCDM is still under construction and standardization, 78% of the respondents to the posted questionnaire were optimistic that the model is an improvement to land information infrastructure. Only 22% out the 44 respondents, who confirmed knowledge about the CCDM as of 2010, were of the view that the cost involved in building the infrastructure and maintaining it, is a disincentive to functional efficiency. As stated by one of the respondents, *"the success of the Model will depend much on implementation since the design has already being given a lot of attention"* (qualitative survey, 2010). The implementation of information infrastructure varies from country to country depending on the mode most conducive to that country. Whilst some countries like

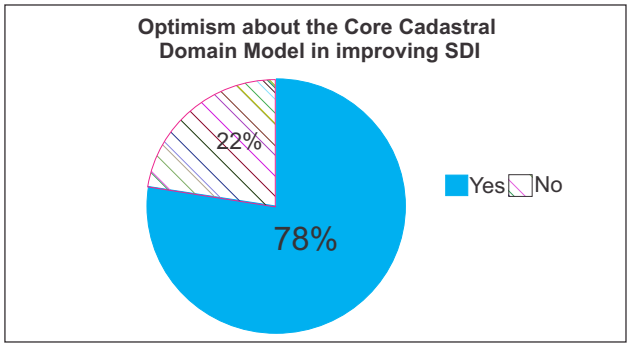


Fig. 6. Knowledge about Core Cadastral Domain Model (CCDM)

Source: Author, 2010

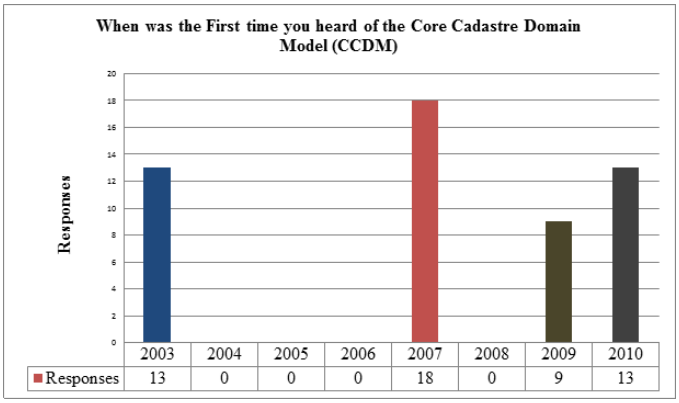


Fig. 7. Year of First Time Knowledge about the Core Cadastre Domain Model (CCDM)

Source: Author, 2010

Brazil, Argentina, and Indonesia have pushed for purely government-ran land information infrastructure, others like Switzerland and the Netherlands have also opted for purely private sector control.

The strategy or choice of implementation purely relies in the bosom of the country in question. However, from the data collected from SurveyMonkey platform, it is deduced that the most preferable system for implementing an effective information infrastructure in Ghana is a combination of both public and private sectors. As one of the respondents put it,

> to implement CCDM as a land information system in Ghana will require dedicated government initiative and investment, and with vibrant, but regulated private sector participation (qualitative survey, 2010).

These responses are illustrated in Figures 8 and 9 below. The key roles of government can, however, not be discredited in investing in creating the platform for information infrastructure. For example, government may provide the needed funding base put in place, compelling legislations, functional insurance and even physical infrastructure needed to roll out land information systems. Following the responses received, it is believed that the CCDM, now known as the Land Administration Domain Model, since 2009, has a lot to offer in improving information infrastructure. Some of the key advantages have already been identified in the model per its simplified design, clear key concepts and manageable parameters.

In Figure 8, the views of the respondents were sought to find out if they strongly believed that the CCDM would improve on information infrastructure in Ghana and, if so, which stakeholders did they think should spearhead this agenda. From Figure 8, 95% of the respondents were of the view that the CCDM had a lot of advantages towards improving land information infrastructure. The remaining 5% were of the view that,

> *developing countries cannot benefit from this kind of model due to known structural limitations*. It is going to increase service cost and a lot of poor people cannot afford it (qualitative data, 2010).

Though the concerns of this class of respondents is genuine to a large extent, it is also the case that, land services delivery will be greatly streamlined and cost in terms of time will be considerably reduced.

With the key attributes of datasets in the CCDM,

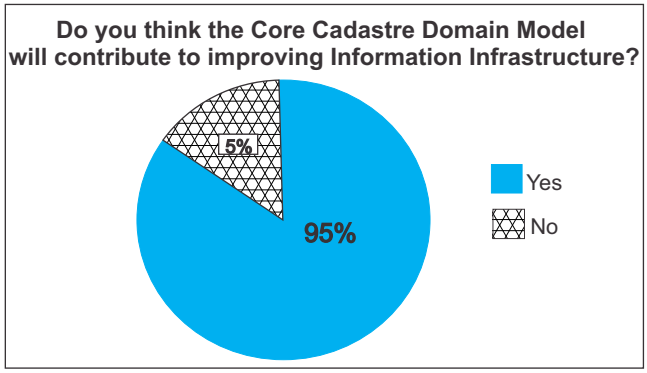


Fig. 8. Potentials of Core Cadastre Domain Model in improving Land Information I

Source: Author, 2010

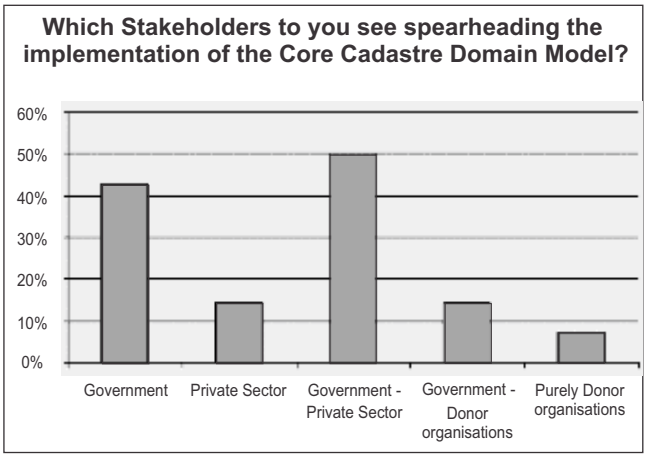


Fig. 9. Core Stakeholders to spearhead Land Information Infrastructure (LII)

Source: Author, 2010

it completely gives all relevant information about the spatial commodity. CCDM has gone beyond the core ideas of Cadastre 2014 to include a wide range of rights, restrictions and responsibilities (private and public law). In the words of another respondent from SurveyMonkey:

> the model contains basic relation of person (natural or juridical), basic unit (could be land) and property rights, restrictions and responsibilities in a uniform way that allow cadastral data to be shared (qualitative survey, 2010).

With the wide extent of details captured under the Model, the CCDM will increase the relevance of spatial data. It is true that data users now require precise and authentic data that is cost-effective, time-efficient (to access) and can support multi-purposes. Spatial data should be able to meet priorities, such as, emergency management, natural resource management, water rights trading, animals, pests and disease control (Williamson, 2008). In this regard, the CCDM will improve information infrastructure positively.

In the words of Rajabifard *et al*. (2006), one good quality of SDI is to create enabling platform linking data users and providers on the basis of the common goal of data sharing. In this regard, there is the need for strong collaboration among spatial information organisations (both public and private) to allow for information exchange. This will harness key institutional capacities to be able to handle the wider scope, large size and complexities of data/services more effectively than they could individually provide. As part of the objectives of the Model, it will *"avoid re-inventing and re-implementing the same functionality over and over again, but provide an extensible basis for efficient and effective cadastral system development based on model-driven architecture"* (van Oosterom, *et al.,* 2003, p. 1). The CCDM has more to offer to information infrastructure than a cadastre can do ordinarily.

As stated by the ISO Technical Committee Report (2010), the CCDM will link spatial objects by geometry. The CCDM is extended with the possibility to store links between spatial units in different topics. Generally, spatial units are arranged in independent topics. Cadastre 2014 has no explicit link between spatial units in different topics, though they may be created when needed, with the help of a spatial overlaying technique. As presented by a respondent: *"the CCDM is an integration of both a cadastre and register. It seeks to present data in 3D to reflect its unique characteristics"* (qualitative data, 2010). These characteristics, indeed, are improvements to SDI and an extension of the original ideas of Cadastre 2014. It is fully in support of the One-stop-shop concept for land administration as propagated under the Ghana Land Administration Project.

A good Information Infrastructure (II) should include the administration and institutional aspects in its features, enabling both technical and institutional aspects to be incorporated into decision-making. It is an objective of the CCDM to facilitate cadastre data exchange between in-country organisations (such as, National Agencies and Municipalities) and between countries (van Oosterom *et al.,* 2003, p. 3). If it is agreed that administrative and institutional cooperation is a hallmark of a good information infrastructure, then, indeed, the Core Cadastre Domain Module is an improvement in land information infrastructure, since it satisfies this key criteria.

8.0 Conclusion

Indeed, following the key attributes and intents of the CCDM, one can conclude that the Model is not just an innovation in land administration, but, to a greater extent, an improvement to information infrastructure, in general. The flexibility of the Model – allowing countries or institutions to

vary components to suit their requirements, background and needs is commendable. The simplicity of the Model will facilitate easy comprehension and usage. Countries also have the liberty to develop and follow their national roadmap for SDI implementation: develop clear vision, build national capacity, integrate different spatial datasets, establish all needed partnerships and provide financial support for an SDI establishment. It is appropriate that institutions, such as, the International Federation of Surveyors (FIG) and European Union (EU), with their wide membership base, are spearheading the further development of the Core Cadastre Domain Model. As recommended also by the developers of the model, a *'co-ordinating group is needed who can further identify the driving force. .... The 'model boundaries'* (what should not be included, what should be included) require further investigations: rights, restrictions, responsibilities related to land should be included and an extension of fiscal rights and responsibilities' (Lemmen *et al.,* 2005, p. 6). In Ghana, the Ghana Institution of Surveyors (GhIS) will qualify for a core implementation agency, together with the Ministry of Lands and Natural Resources, through the Lands Commission.

For the efficient workability of the CCDM, there is also the need for institutional cooperation (with each supporting the maintenance activities and the information supply of parts of the dataset), data integration (with different organisations have their own responsibilities in data maintenance and supply and have to communicate on the basis of standardised processes in so-called value adding production chains), regulating frameworks (that relate to data acquisition, data modelling, data maintenance and data sharing) and all these hinged on a strong public – private sector coordination. The grounds for these are already laid in the passage of the Lands Commission Act, 2008 (Act 767) and the institutional reforms which put all land agencies under the Lands Commission. Though the adoption of the CCDM comes with a huge capital requirement on both establishment and maintenance, it is still worth the investment, considering the numerous benefits it stands to bring. All direct and indirect beneficiaries of the Model, e.g., banks, tax agencies, real estate companies, etc., should, therefore, throw their weight behind its successful implementation.

With the above exposition, it is confirmed that the CCDM is an information infrastructure for spatial dataset acquisition, processing, storage, maintenance and distribution. Indeed, it has much to contribute to improve information infrastructure positively in developing regions that are still battling with difficulties in their land sector. With its ability to allow for data interoperability, flexibility to adapt to local needs and friendliness to use by even non-ICT specialist, the timing of the model as an intervention in spatial data management is perfect.

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