Developing a Framework for Cadastre and Land Registration Systems in Land Administration Organizations

Arbind Man TULADHAR, The Netherlands

Key words: Cadastre, Property, Organization, LIS, Geo-ICT.

ABSTRACT

International practitioners often indicate that there is increasingly demand for a reliable and effective shared framework for developing, operating and maintaining land information systems in the developing countries especially when existing systems are no longer coping with the current market demands such as policy shifts in land issues and geo-information technology (Geo-ICT). This research paper provides systematic approach by providing management framework for developing cadastre and land registration system in Geo-ICT environment. As a case, this paper firstly examined the current systems of property rights and its registration services in Nepal to assess institutional and operational aspects toward the changing market needs. Consequently, a management framework is proposed; the system development phases for a land information system (LIS) are discussed with focus strong on reengineering the existing business processes of the cadastre and land registration. Then a sample model using Unified Modelling Language (UML) is provided to show that modelling technique can be helpful to communicate with top managers and executives in land administration organizations. Finally, the experiences suggest the coordinated efforts on management and development must be put for the successful implementation of the envisaged system.

CONTACT

Mr. Arbind Man Tuladhar, Assistant Professor
Division of Geo-informatics, Management and Infrastructure
International Institute for Geo-information Science and Earth Observation (ITC)
Hengelosstraat 99
7500AA, Enschede
THE NETHERLANDS
Tel. + 31 53 487 4312
Fax +31 53 487 4335
E-mail: Tuladhar@itc.nl
Web site: http://www.itc.nl

Developing a Framework for Cadastre and Land Registration Systems in Land Administration Organizations

Arbind Man TULADHAR, The Netherlands

1. INTRODUCTION

In many developing countries, there are many factors ranging from political, legal, financial, social and cultural situations that are affecting in developing, operating and maintaining cadastre and land registration namely Land Information system (LIS). In this paper, we discuss only two main aspects that influence these issues. For such LIS, firstly we need to understand the systems of property rights inherited from the traditional land tenure systems, and what instruments are applied to realize land policies. For this, we take a case from Nepal, because the author is familiar with the situations. Second aspect that is most challenging is the management aspects in dealing with land policies, and developing and operating an appropriate system. For this, this paper emphasizes the development of a management framework and highlights reengineering/redesign approach for business processes using a Unified Modelling Language (UML).

2. PROPERTY RIGHTS: A CASE IN NEPAL

Nepalese society is very much based on agriculture productivity, and it is estimated 42% of the population living are below the poverty line. In such agriculture society, where more 80% of the total population depend on agriculture and natural resource for their subsistence and income earning, land rights are fundamental to the society including those groups of people such as poor, landless and women. Although, these groups work for most of their time on land and feed their families, they are normally least able to defend their rights on land. In addition, secure land rights are essential for equity.

In Nepal, it is estimated that are about 6 millions land holders holding 19 million land parcels (Bhumichitra, 1996). If total population in Nepal is estimated to 23.6 millions as indicated by the preliminary result of 2001 census, then about 25% of total population holds land. Moreover, many of them have difficulties to defend their rights especially of those rural poor and women. Land reform programme (HMG MLRM, 1996) initiated in 1964 has brought to a simple land holding system such as 'Raikar' (individual) and 'Guthi' (trust) lands breaking down complicated and traditional land tenure system. The present Raikar tenure system allows the distinct relationships between the land holders and land through a bundle of rights, which can held, used, sold, devised, mortgaged and inherited by the land holders under the conditions that they keep paying the tax annually fixed by the state. The trust institutions hold the ownership rights on Guthi lands, but the rights of use can be alienated to individuals under the conditions imposed by the trust institution (Tuladhar, 1998).

However, this simplified land rights brought the constant struggling in the relationship of landowners and tenants. They did not influence on securing land rights and thus far reaching impacts on capital formation in the agricultural sector. Despite the high sounded objectives

and policies, neither the landowner nor the tenant had incentive to invest in the improved productivity of the land. Tenants could not be evicted according to law reducing landowner incentives. And, tenants did not have ownership incentive to invest in the land. So land reform did not adequately change land rights incentive needed to improve agriculture outputs. The programme did not also address issues of land taxation that favors rich and large landowners who pay very little nominal land tax.

The sample survey indicates that 0.3% of landowners make annual transaction in remote and rural areas while 21.8% make transaction in urban areas of Kathmandu suburb areas (Bhumichitra, 1996). These figures suggest that the extent of land transaction is very low in the remote areas where any new individuals from the other communities/villages hardly go and purchase land. It is also possible that transactions in remote areas take place on informal basis without going to the district registry office, because they cannot afford traveling and registration costs. But in Kathmandu valley areas, the extent of transaction is high due to the population growth and migration from the remote areas to the capital city, where employment and other economic opportunities are high and people in the city can afford the cost of transaction.

In early days in Nepal, land transaction usually takes place mainly among members of families within their own communities (either through inheritance or gift). In such case, all concerned parties know information accurately. In city areas and other developed areas, with advanced stage of development (more infrastructure and access) and increased mobility of individuals, land transactions among individuals who are not member of the same community/village are now more frequent. As a result the scope for inaccurate information, hence land dispute, increases. Hence there is an urgent need of a very good system of cadastre and land registration for timely supply of reliable information. Despite the use of mediation techniques to resolve disputes, Nepal society suffers from the high percentage of land dispute cases.

Realizing lack of geo-information at all levels of government administration, skewed distribution of land, inefficient agriculture products and lack of credit, the critical issues that relate the fundamental rights on property and the need for reinforcing land reform programme are clearly mentioned in the Constitution of the Kingdom of Nepal 1990. That means that systems of cadastre and land registration must be appropriate and must function very well.

3. CADASTRE AND LAND REGISTRATION AND GEO-ICT: CHALLENGES

The rational behind establishing the cadastre and land registration is to treat a uniform basis throughout the country for levying the land tax and implementing land reform policy. The systematic compulsory land recording has been covered by the cadastral surveys including land registers in all districts. This system may be considered as one of most simplest and low cost system in the World. Due to its simplicity, it was possible to decentralize its operations to the district and local administrative levels under the ministry of land reform and management (MLRM). It is estimated that there are 81,223 maps at the scale varying from 1:500 for urban areas to 1:2,500 for rural and large parcel areas. There are about 44,125 moths (land ownership registers). The cadastral surveying method is purely ground method

using graphical technique using telescopic alidade on plane table and metric staff. Not all maps are geo-referenced to the national geodetic framework system.

As a result of establishment of initial cadastre and land registration, the cadastral major service are available and the available products at each district offices are the cadastral maps, cadastral records, tax-registers and unregistered parcel records (Shrestha, 1999 and Survey Department, 1998). Cadastral maps are prepared based on geodetic control points and contain parcel numbers, boundaries (parcels and administrative units of ward, local village, district, zone, region and international), man-made objects (building, walls, fence, roads, telephone lines and power lines), vegetation (forest, orchards/nursery, trees and plantation), water bodies (rivers, streams, lake, canals, tube wells, natural water sources) and public services (parks, temples, mosques, post offices, police station, hospital and schools).

Cadastral record known as 'field book' is the record of all the individual parcel of land contained in one map sheet. Each land parcels are numbered consecutively. The landowners are identified with tax-receipt they produced as an evidence of ownership. If there were any tenants on any land parcel, their names and addresses are also written down. It also contains size of parcels and land use types. A loose-leaf-binder is used for a tax-register, popularly known as "land-ownership register" and is meant for collecting land tax. It contains all the land parcels of a village, and is indexed by the reference to the parcel number. Unregistered parcels are also compiled from field books in loose-leafs. Unregistered parcels are those parcels over which the claimants remain absent and did not produce tax-receipt and the village representative does not attest the absentees. The records also include all government and communal land.

District land revenue department together with District survey maintenance office handles further land transactions. Full transfer of land ownership can be done normally within a day, if there are no subdivision and no complication on land ownership certificate (such as mortgages, restrictions, etc.). Registration system is based on improved deed registration system using basic principles of cadastre systems. The process steps are established and organized in the forms of manual steps; there are number of challenges currently facing by the organizations. Internally the quality, consistency, standardization, accessibility, verifiability and clarity of information can hardly be maintained. There are several issues. Firstly, all these records are in paper forms that are in poor conditions due to limited funds. The staffs make much effort to extract information, which are still unsatisfactory. The staffs are very poorly educated and lack knowledge in management (Acharya, 1992). Secondly, there are many unorganized records including mortgage, restrictions and easements records, which are often duplicated data and do not match with cadastral and land ownership records. Thirdly, there are no legal status on data quality, obligations and copyrights on sharing of these data. There are no formal basis for fees on land transaction and data sharing. Surveying technique for subdivision of land parcels is based on old ground survey methodology. There are no formal procedures to satisfy the landowners. There are many artificial barriers between users, staff and organization itself. Lastly, the mismanagement of the local district offices (registry and survey) has caused many problems such as double registrations of land parcels, delays in services, increase in fraud cases, malpractice by the staff and even need of re-survey the entire village or district (Bhumichitra, 1996).

Realizing above challenges and bottlenecks, a LIS project was initiated in the early 1995. It could not produce any convincing results with unexpected over-budgeting or failing to provide effective services in time. Beside them, major challenge is management ”how to manage such project which has tremendous impact on traditional organization and how to introduce Geo-ICT to improve businesses to response the changes in policies and customer demands”. The Ministry of Land reform and management (MLRM) took a major step to create a new department as “Department of Land Information and Archive (DOLIA)” on November 2000. Its major missions are to introduce ICT in land administration and management in the kingdom and to supply land information to all concerned parties including the decision/policy makers for agriculture productivity, poverty alleviation and environmental conservation contributing to the good governance in the civil society (DOLIA, 2001).

In many developing countries like Nepal, its major difficulties are to cope with fast technological changes in Geo-ICT environment, lack of management framework for developing customer-oriented cadastre and land registration system using Geo-ICT, co-ordination of stakeholders, availability of well-trained human capacity, and finally financial resources. Additionally, experts so called Geo-ICT managers have to maintain currency with emerging technologies, and deal with the shortage of Geo-ICT skilled worker and aging technical infrastructures.

4. MANAGEMENT FRAMEWORK FOR THE DEVELOPING CADASTRE AND LAND REGISTRATION

The international initiatives such as The Bogar Declaration (UN-FIG, 1996) and The Bathurst Declaration (UN-FIG, 1998) strongly indicate that cadastre and land registration systems worldwide are currently undergoing major changes. For such initiatives, a framework for managing system development process has to be formulated depending upon the particular situation and circumstance of the organizations in the country.

Since Geo-ICT influences every part of existing business, organizations and people, the management of process for system developing is extremely important especially when Geo-ICT is involved, constantly changing, and have to maintained. On the basis of the special circumstances and challenges in the context of Nepalese society, a management framework can be developed for a national LIS, and shown in the following figure no.1.

The framework consists of nine components that organizations have to deal in order to implement, operate and maintain the system successfully. These components are: environmental factors, strategic issues, Management aspects, Business processes, Geo-Information technology, data models, organizational aspects including people and finally products, services and performance.

The framework tends to be strategy driven with top management interpretation of environmental and competitive factors. In reality, this is necessary to obtain top management support to realize governmental policies and market needs. Strength, Weakness, Opportunities, Threats (SWOT) analysis can be employed to study environmental factors and

to develop strategic visions and objectives. Since it attempts to challenge existing assumptions concerning organizational systems, the programme for building human capacity is a necessary condition especially in domain of geo-information technology. It is generally known and recognized that resistance to change is high and attempts are needed through an assessment of cultural readiness and to apply change management concept.

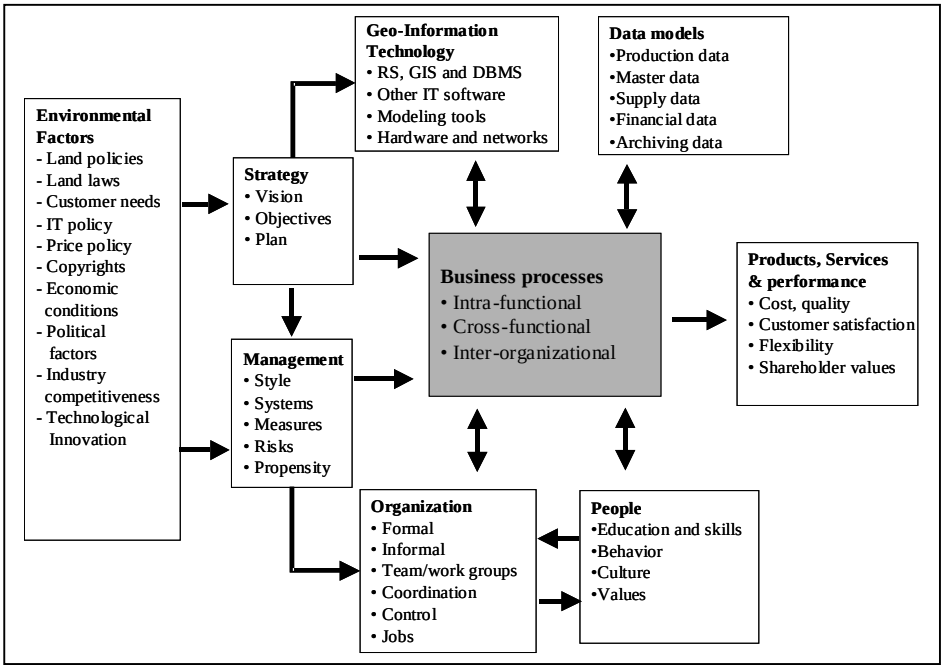

Figure No. 1 – Management framework for developing cadastre and land registration

In administration organizations, data and information need to be stored and managed with proper security system and media. For this, data models are developed and synchronized well with the business processes. Business processes and data models are designed and tested concurrently during modeling phases.

Business processes generally focus on cross-functional and inter-organizational processes (Godinez & Tuladhar, 2001). They take the customer/stakeholder view and leverage ICT's coordination and processing capabilities. It is essential to include activities to empower individuals and teams and accommodate measurement of performance gains particularly as they related to customer satisfaction and profitability.

The essence of this framework is that it allows us to apply the modern technology of business reengineering concepts and tools to develop optimal business processes required for cadastre and land registration using Business Process Reengineering with continuous process improvement approach (Jacobson, Ericsson & Jacobson, 1995).

5. BUSINESS PROCESSES: REENGINEERING APPROACH

Currently many organizations (governments, universities, semi-governments or private companies) including the Ministry of Land Reform and Management (MLRM) in Nepal are increasingly relying on Geo-Information in digital format to manage and make decisions especially in the field of geographic information systems. With the initiation of the national ICT policy by National planning commission (NPC), executives and decision-makers in government agencies are looking opportunities to incorporate innovative technology into the way government works. But department of land information and archive (DOLIA) of MLRM is grappling with a number of complexities such as significant policy shifts in land issues, changing market demands, budgetary constraints, and the unique decision-making environment.

In many system development projects around the world, government agencies work in partnership with the private sector and the academic community in the pursuit of new ways to use computing and communication technologies to solve practical service delivery and administrative problem.

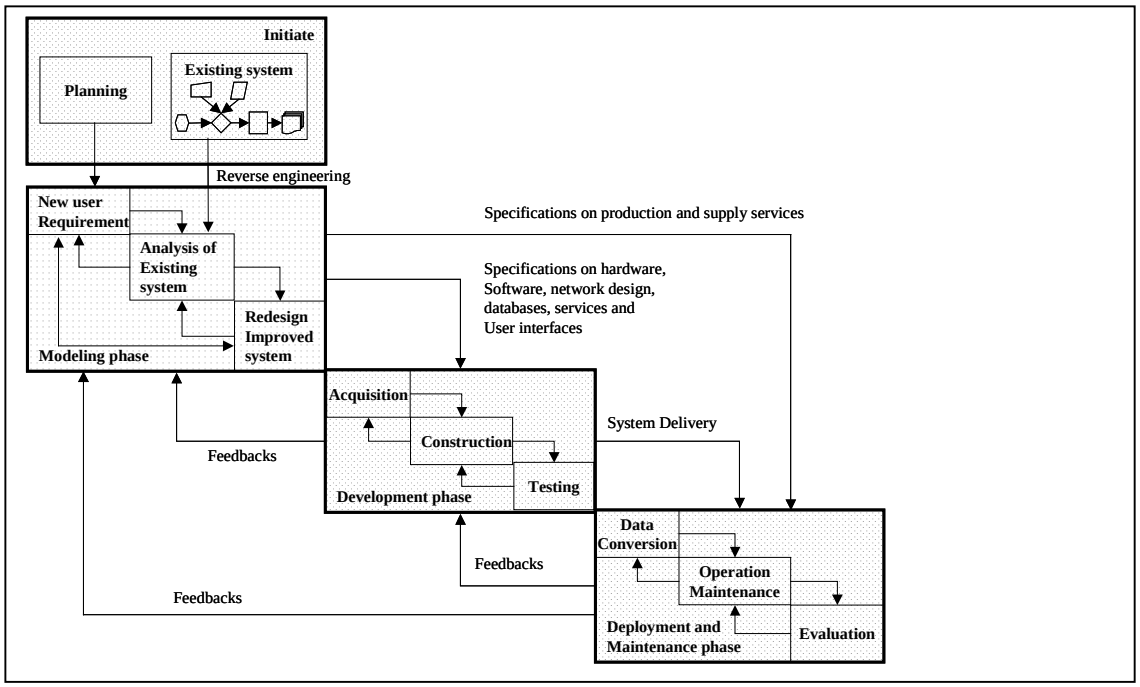

Figure no.2: Reengineering phases for cadastre and land registration

The four major phases can be identified for reengineering purpose and shown in the figure no. 2. These phases are incrementally improved through the feedback system at all level of organizations.

Initiation phase. In this phase, a steering committee at the ministerial level comprising senior executives and top experts knowledgeable about the organizational tasks is formed to guide all steps necessary steps for reengineering. A team is formed and usually consists of champion and top experts in the land issues, cadastral fields and Geo-IT. It then initiates a vision of how its business processes have to be developed so that it attains its strategic objectives based on a review of strategy and Geo-IT opportunities in the hope of improving the overall performance. It also sets the performance goals, project planning and stakeholder/employee notification. This can be achieved by developing a business showcase for reengineering via benchmarking, identifying external customer needs and cost benefit analysis.

Modelling phase. Modelling is an essential activity when dealing with the inherent complexity of business processes like cadastre and land registration systems where many customers/stakeholders and landowners are interested. Models help us to understand business processes by representing only essentials or, in other words, eliminating everything the customers/stakeholders consider irrelevant to what we want to consider.

By examining *user requirements* or by abstracting what the users need, the models can represent business processes or services in a clear, concise way, thus providing insight in their structure, the dependencies between processes, the time scales on which they operate, etc. This is very important when the services or products need to deliver in time.

Understanding the existing business of survey and land registry offices is essential for reengineering their functions and tasks. *Reverse engineering* allows us to bring these current business processes to models. We can *analyze* them to find bottlenecks. Through analysis, models can be made at all levels of system under development including processes for data population, handling, data storing/archiving and data supply such as issuing certificates or maps. Models may also help us in *redesigning or reengineering* and evaluating changes. They can be used to evaluate changes in the "model world" before they are implemented. Processes such as manual corrections of cadastral maps having no value or not relevant to the organization can be replaced by Geo-IT and verified using a modeling language. In this situation, a new process design is developed. This is accomplished by devising process design alternatives through brainstorming and creativity techniques. The new design should meet strategic objectives and fit with the human resource and Geo-IT architectures. Documentation and prototyping of the new process is typically conducted and a design of new information systems to support the new process is completed.

Models can be translated into a set of specifications such as business functions, data models for databases, user interface models, operating systems, hardware and software, networking, communication system, etc. for development phase. Since models mostly consist of a series of diagram, it facilitates communication to the steering committee or members of the organizations about the business processes by creating a common frame of reference. Models are a mean of communication that helps to understand processes and to document them.

Development phase. During modelling phase, one would realize what hardware and software are necessary for the organizations to function business services. Since not all

business processes are implemented at one time, utmost care should exercise to prioritize necessary hardware and software for the entire life cycle of system development. In the first phase, the project could start by acquiring some hardware and software. If intended objectives are fulfilled, then start with next phase. These days, a variety of software is available in the market and choices will be difficult. Experts in the field of GIS, databases, networking and other programming software should be consulted. While acquiring them, one has to comply with the national IT policy and other government regulations.

After acquiring necessary hardware and software, they have to be installed and tested. The environment conditions for the office rooms (for Servers and Clients) where these equipments are to be installed should be kept to the required levels (working spaces, humidity, temperature, etc.). Proper security system is required so that no unauthorized officials are allowed to enter the rooms. Tests are necessary to comply with the specifications. The practice shows that it may be wise to use real data sets in some situations. Application programs including user interfaces are developed to suit the requirements of the customers. Databases are physically designed and installed.

At this stage, we may already want to give some responsibilities to the staff. It relies heavily on change management techniques to ensure smooth migration to new process responsibilities and human resource roles. During this stage, the IT platform and systems are implemented and the staffs go through training and transition.

Deployment and maintenance phase: Once the systems are installed, the data collection and conversion can start using the operating manuals as provided by modelling team and suppliers of hardware and software companies. The discrepancies should be notified regularly, so that the next versions of operating documents could be developed.

In principle, services can now start. But start with experimental basis to see if there are any problems. Any problems encountered or unsatisfactory products or performance of services are notified to the supervisor for further necessary actions. Hardware and software must be maintained whenever the some defects in software or breakdown of hardware occur. Regular backup must be made according to plan. The last stage is evaluation, which requires monitoring of the new process to determine if it met its goals and often involves linkage to the organization's total quality programs.

6. MODELLING USING UNIFIED MODELLING LANGUAGE (UML): SUMMARY

To model business processes, we need a modeling language. A primary requirement is the correspondence between the elements of the real world problem (in our case cadastre and land registration) that are subject to our analysis, and language constructs of the modelling language.

The UML is one of most popular languages used for analyzing and modelling system problems in system development process environment. It is based on very specific notations and diagrams with the related grammatical rules for constructing models as part of object-oriented design concepts. It supports a rich set of graphical notation describing classes,

objects, activities, states, workflow, use case, components, nodes and the relationships among them. Hence, it provides significant benefits to system designers and organization by building rigorous, traceable and maintainable models, supporting development lifecycle.

One of main advantages of UML is that both dynamic and static aspects of the cadastral and land registration problems can be studied, modeled and verified iteratively until we are satisfied without proceeding to the next phases.

An example of dynamic aspects is *Registration of deeds of transfers*, which continuously updates or changes spatial and non-spatial databases located at the different organizations, when the requests comes to cadastre and land registration offices. Such dynamics can be modeled, verified and maintained easily during modelling phases with the helps of use case models, activity diagrams and object models. Use case describes the functionalities of the business services to interact between a user and the system. To realize appropriate behaviors semantics such as 'include' or 'extend' are provided to include another use cases. These semantics are extremely important for land registration to explain why a certain processes are more expensive and time consuming without going into details. Activity diagrams are needed to understand the workflow of a certain activities to realize business services or use case.

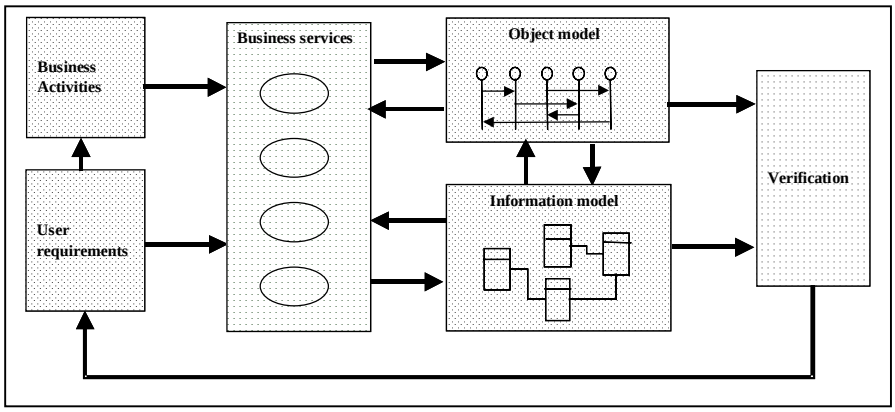

Figure No. 3: Dynamic and static aspects of system

Once we identify use cases and activities, the next tasks would be to identify necessary information model containing classes, properties and operations that are required to realize use cases. This is, in fact, static components, because classes in the database do not change. What changes are the objects? For example, in relational databases, tables and corresponding attributes are fixed, but attribute values are being updated, deleted or added.

Interesting things of UML is that we can develop an object model that shows how different objects interact and collaborate each other in time sequence. This is done through interaction or collaboration models to realize a process or a use case. At the modelling phase, iterative procedure can be designed improve use case model, information model, object model and finally a sequence of workflow for business activities. At our institute, experimental tests are being carried for developing such models in cadastre and land registration system, and

topographic mapping system and initial results found to be satisfactory to fulfill the requirements of the users/stakeholders.

7. CONCLUSIONS

A simplified system of property rights in Nepal needs to be reinforced by developing a good land information system, in which strategic development and modelling of business processes and data models are most critical phases.

Reengineering has to approach from the strategic policies and needs with strong focus of customer/stakeholders at all levels of management. Management framework is needed to manage changes in the existing organizations especially with Geo-ICT innovation. Business and Geo-ICT policies should be matched at all level. Program must focus on minimizing data duplication and maximizing data sharing to reduce unnecessary over-budgets within the context of Geo-spatial data infrastructure (Groot & McLaughlin, 2000).

A learning model (prototype, evolve, measure) in developing a system is required. It is best to start small and allow for evolution based on working experience. By paying attention to the goal from the start, one would be in a position to measure the results against expected objectives and improve system incremental steps. UML allows this type of learning model.

A very important factor in ensuring project success is the commitment and professional dedication of the Geo-IT and program staffs, who design and develop the system.

REFERENCES

Acharya, B. R. (1992). *Structured development of a multipurpose cadastre in Nepal with emphasis on the development of a strategy for the definition of user needs*. Unpublished M.Sc. Thesis, ITC, Enschede, The Netherlands.

Bhumichitra Co, Pvt. Ltd. (1996). *Detailed study report on developing an intergrated land information system*. Submitted to the Ministry of land reform and management Singha Durar, Kathmandu, Nepal.

DOLIA. (2001). *Vision, objectives and challenges.* Departmental publication. His Majesty's Government, Ministry of Land Reform and Management, Department of Land Information and Archive (DOLIA) April 2001, Kathmandu, Nepal.

Godinez, E. Y. & Tuladhar, A. M. (2001). *Maximise data sharing, Minimise duplication: Development of a cadastral infrastructure in Guatemala*. GIM International, Volume 15, August 2001, pp 56- 59.

Groot, R., & McLaughlin, J. (2000). *Geosptial data infrastructure: concepts, cases and good practice.* Orxford, UK: Oxford University Press.

HMG MLRM (1996). *Half yearly ten point preparatory measures for land reform.* Publication series. HMG, Ministry of Land Reform and Management (MLRM), Singha Durbar, Kathmandu, Nepal.

Jacobson, I., Ericsson & M. Jacobson, A. (1995). *The Object advantage: Business Process Reengineering with Object Technology*. ACM and Addison-Wesley Publishing Company.

Shrestha, B. L. (1999). *Land Registration in Nepalese perspective*. Published by Nepal Survey Society, Min Bhawan, Kathmandu, Nepal.
Tuladhar, A. M. (1998). *Land Ownership Structures and implications on Land Information Systems in Nepal*. FIG International Congress, Brighton, UK.
Survey Department. (1998). *National Mapping (issues and strategies).* Survey department, Kathmandu, Nepal.
UN-FIG (1990). *Bogor declaration on cadastral reforms*. Indonesia. 1990.
UN-FIG (1999). *Bathurst declaration on on land administration for sustainable development.* Australia. 1999.
Van der Molen, P. (2001). *Cadastres revisited: The promised land of land administration. Inaugural address.* ITC, Enschede, The Netherlands.
Williamsom, I., Ting, L. (2001). *Land administration and cadastral trend – a framework for re-engineering.* Computer Environment and Urban systems, an International journal, Theme Issue: Cadastral systems, edited by C. Lemmen & P. van Oosterom. Elsevier Science Ltd.

BIOGRAPHICAL NOTES

Mr. Arbind Man Tuladhar is working as Assistant Professor at International Institute for Geo-Information Science and Earth Observation (ITC) in the Netherlands. He has 25 years of experiences in land administration and national topographical mapping. During the periods, he has gained tremendous knowledge in the use of geographic information systems, database management systems, system development methodologies and use of various CASE tools. He has also applied them within the context of Geo-spatial data infrastructure. He is a life member of Nepal Geographical Society and Indian National Cartographic Association (INCA). He has published many articles.