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Application of GIS for Rural Land Registration

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1. Introduction

During the past two decades, applications of GIS have made a great deal of progress. The use of GIS in land administration is one area where the technology is being used widely at the present time. Since the 1990s, many countries, both developed and developing, have been applying GIS for land administration purposes.

As GIS and associated technologies mature and more data become available in computerised form, the use of GIS for integrating land-related data becomes more suitable. Improvements to the existing land administration systems are being made through developments in the technology. In order to provide both administrators and data users with accurate and up-to-date information about the land, more rapid and efficient systems have been developed for data capture, storage, updating and distribution. The advance of GIS technology to support very large spatial DBMS, the availability of digital maps, and the proliferation of higher network bandwidth, have all promoted the provision of map-based National Land Information System (NLIS) solutions.

Through the adoption of Internet and Intranet solutions, the latest generation of NLIS are providing wider access to geographical information. The advantage of this technology is that users can access the information using standard Internet browsers (Coleman 1999). Successful NLIS require spatial referencing standards and appropriate GIS technology to support spatial data servers, federated DBMS, temporal management, efficient WAN (Wide Area Network) technology, and efficient client customization tools. Therefore, the application of GIS technology to the land registration activity in Ethiopia would be a suitable solution provided that its advantages and shortcomings are well understood.

2. Objective

GIS technology is being extensively used in many countries for land registration and administration purposes. In fact it has become the underlying technology on which land Information Systems (LIS) are based on. In Ethiopia, GIS has been used for urban cadastre and other information systems related to land and the environment. The objective of this paper is therefore to identify the various issues related to applying GIS technology for the purpose of land registration projects in Ethiopia.

3. Requirements for Applying GIS for Rural Land Registration

In order to use GIS technology to create a rural land registration system, there are certain requirements that need to be fulfilled which would in turn assure the success and sustainability of the system.

A summary of the four major phases in implementing a computerized land registration system are as follows (Tuladhar 2002).

a. Initiation phase

In this phase, a steering committee of senior executives and top experts knowledgeable about the organizational tasks is formed to guide in all the required steps. A team is formed and usually consists of top experts in land issues, cadastral and Geo-IT fields. It then initiates a vision of how the system has to be developed so that it attains its strategic objectives based on a review of strategy and Geo-IT opportunities. It also sets the performance goals, project planning and stakeholder notification.

b. Modeling phase

Modeling is an essential activity when dealing with the inherent complexity of systems such as cadastre and land registration. Models help us to understand the processes by representing only essentials or, in other words, eliminating everything the stakeholders consider irrelevant to what we want to consider.

By examining *user requirements* or by abstracting what the users need, the models can represent processes or services in a clear, concise way, thus providing insight into their structure, the dependencies between processes, the time scales on which they operate, etc. Through analysis, models can be made at all levels of system, 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.

Models can be translated into a set of specifications such as 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 diagrams, 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 means of communication that helps to understand processes and to document them.

c. Development phase

During a modeling phase, one would realize what hardware and software are necessary for the organizations that would provide the land registration service. Care should be taken 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 the 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 the necessary hardware and software, they have to be installed and tested. The environment conditions for the office rooms (for Servers and Clients) where these technologies are to be installed should be kept to the required level (working space, humidity, temperature, etc.). A 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 certain requirements. Databases are physically designed and installed. During this stage, the IT platform and systems are implemented and the staff go through training and transition.

d. Deployment and maintenance phase

Once the systems are installed, the data entry and conversion can start using the operating manuals as provided by modeling 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, associated services can now start, but this should be on an experimental basis to see if there are any problems. Any problems encountered are notified to the supervisor for further action. Hardware and software must be maintained and 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.

A recent example in Africa of a computerized land registration system project from which experiences can be gained is the Egyptian Cadastral Information Management Project (ECIM) implemented by the Egyptian Survey Authority (ESA). The project’s purpose is improvement of land information system for cadastral services and its links to land registration and land taxation. This in turn, aims at better security in land ownership and transaction and a more sustainable management of the nation’s land resources, and eventually at reducing poverty.

The ECIM Project develops a computerized system for cadastral work, data storage and updating. The system consists of ESA data and workflows, and the information exchange links between ESA and land registration and land taxation. The three-year project which started in March 2002 builds a pilot system in one province that can, if successful, be applied nationwide.

The GIS chosen (Oracle, ArcSDE, ArcCadastre, and MapObjects) was customized to include automated procedures to continuously update graphic and attribute data. Due to the current level of communication infrastructure in Egypt, de-centralized system architecture was chosen (Elrouby, Harju, and Corker 2005). Each EDO, ESA District office (totally 180 of them in Egypt) will have spatial and attribute data from its jurisdiction in a database in Oracle 9i Personal Edition. The server containing the UCD in Oracle 9i Standard Edition, will be placed in the EPO, ESA Province office (26 in Egypt), and will contain the data of all the districts under it. During each night, there will be automatic data synchronization done between Province and District databases by exchanging database updates via dial-up modem connection. All map updating is under the responsibility of the Province, and it will be done by customized ArcCadastre software. The District office performs its tasks using customized light GIS application with map viewing and printing, but not spatial updating facilities.

Another African example that can be cited is the Tribal Land Information Management System being developed by the government of Botswana, which envisages to integrate the land administration work. The system is to have the following functionalities: Land Use Plan, Process Plot Applications, Plot allocations, Change Land Use, Transfer Land Title, Plot Registration, Sub-Divisions, Sub-Leasing / Sub-Letting, Development Control/ Compliance, Acquisition and Compensation, Adjudication and Land Board Revenue.

The proposed LIS will attempt to address the current deficiencies in land administration and management by providing linked data to all stakeholders at different levels of accessibility and data manipulation. The proposed LIS model would have a central database housed and managed by the Ministry of Lands and Housing and this would be made accessible and linked to all relevant stakeholders responsible for land administration and land management. To facilitate the exchange and share ability of information it is proposed that the database be accessible from and linked to the main Land Boards throughout the country.

Therefore, by taking the necessary steps to fulfill the outlined requirements and taking the experience of other countries into consideration, GIS technology can be used to create a successful rural land registration system in Ethiopia.

4. Constrains and Opportunities

A computerized land information system (LIS) development is a complex and long-term commitment requiring substantial funding and understanding of the application of suitable technology. The adoption and use of technical innovations, such as GIS, will bring the novel advances that will improve economic and administrative competitiveness. However, from the experiences of users in various organizational circumstances, we can learn that securing the potential benefits of computer-based technologies, including GIS, can be problematic (Audit Commission 1994; Eason 1998; McRae 1993; Moore 1993). In other words, the process of implementing and utilizing technological innovations is not simply a technical matter but is influenced by a range of cultural, institutional, and organizational settings. It is now understood that the effective implementation of any system of land administration requires the cooperation of a diverse number of government agencies and private sector organizations.

Since a land information system should serve a wide variety of users, both in government and in the private sector, it is essential to understand their requirements. It is also necessary to realize the technical, administrative, and institutional constraints under which the system will operate in order to ensure the user’s support. It may be necessary to provide continuing validation for the system; to reassess the level, scope timing, and source of financial support; and to scrutinize the direct economic benefits derived from the system.

The efficient use of a new technology, such as GIS, in an organization often entails that work routines and chains of command be changed. In turn, the overall organization is influenced. In reality, changing an organizational structure may be difficult, both because some factors of its structure are indefinable and hence difficult to characterize, and because usually there are both formal and informal positions in all chains of command. Transformed work routines require organizational changes. Changing the organization changes staff authorities and relationships (Campbell 1999). The organizational problems are often more complex and essential to success than are the technical problems. Changing and replacing staff is more intricate than changing computers and may cause unexpected difficulties. Thus, organizational matters generally entail more consistent management concern than do technical problems (Bernhardsen 1999).

An unavoidable consequence of computerization is the need for reorganization. The conventional organizational structure is to adopt a functional approach in which separate departments or sections are responsible for each specialist activity. Functional structures have the great advantage of simplicity, for everybody can recognize his or her special task. Consequently, the system is very stable and is well suited for a workload where there are many small projects that must be finished in quite a short period of time. The alternative approach is to form a special project team to tackle a task. This is more suitable to specialized projects, for example, to set up an entirely new system or to carry out major reform and restructuring of an existing one.

Prior to reforming organizational arrangements, attention needs to be on understanding the current government structure and policies, and the current requirements for land information management and the constraints that deter its progress (Dale and McLaughlin 1988). Therefore, there is a need to define the agencies that will be responsible for policy formulation and for routine operations. There also needs to be a body that is responsible for co-ordination. Many present systems suffer from overlapping responsibilities leading to the duplication of data recording for land administration. This makes the maintenance and updating of the records more complex. The control and exchange of land related data require interdepartmental co-operation and some degree of yield of departmental autonomy because many different departments handle these data. Experience so far has suggested that an independent body responsible directly to the highest government authority has to undertake any central co-ordination of land information. The staff for such a body should come mainly from those who already have experience in government but with the additional support of technical experts (Dale and McLaughlin 1988). Their responsibilities will involve co-ordination between diverse ministries and departments, and between central and local governments. The overall control of a single agency should ideally perform both the land registration and land survey functions for land administration. Such an arrangement should guarantee the best possible co-ordination between the various parts of the whole operation. In reality, many countries already have separate institutions, and in practice it is difficult to change arrangements that may be well established politically and historically.

In applying GIS technology to land registration and administration, management issues need to be addressed. Resources need to be allocated to the training and motivation of middle managers; they often hold the key to the implementation of reforms. Senior management unavoidably becomes involved in policy formation. It is the responsibility of the middle manager to guarantee that the jobs get done. Experience has shown that the most important organizational problems are the poor quality of managerial structures for implementing GIS, followed by shortage of skilled staff and the lack of encouragement from senior staff. In several cases staff resistance also presented a significant problem (Campbell and Masser 1995). Governments have their own policies with respect to manpower employment and the extent to which systems must be capital- rather than labour-intensive. Since land information systems have been related to high technology, clear strategies for coping with the impact of such developments need to be worked out. Computerization has extensive effects on the structure and staff categories within organizations. For example, within the routine operations of a land information system there are many specific tasks that are conducted by different category of staff such as system manager, programmer, systems engineer and so on.

Some organizational choices must be prepared at a very early stage. The design of the system, system configuration, and network are affected by how updating is planned. As a rule, new tasks and new data flows may be selected separately from the people, groups, or departments eventually accountable for them. Consequently, new staff structures must be defined, and management adapted subsequently. In fact, GIS implementation projects are often short-handed. Accordingly, staff requirements should be cautiously measured at the outset and the staff skills identified must be made available to the project. In general, this usually entails either that staff members be relieved of their regular tasks and assigned to the project, or that personnel be hired specially for the project.

Many GIS projects, particularly those in the public sector, suffer from lack of training of operators and users. Therefore, personnel management for the transition to a new technology should be given top priority. Ideally, all staff members who have direct or indirect contact with GIS or its products should be properly trained. This also applies to executives, who should have a general understanding of the potential and the limitations of GIS as a tool in decision-making. Middle managers should have an appropriate technical background to organize the implementation of GIS. Field staff and others who obtain data should be trained in its conversion and updating (Bernhardsen 1999). Typically, GIS software system managers and operators need to be thoroughly trained. The preparation of appropriate training and the development of motivation in the staff are by far the most important of all these elements.

Most organizations choose to retrain their own staff in conversion courses instead of employing outside experts. Training should contain on-the-job training as well as official education (Forer and Unwin 1999). The needs for expertise are often underestimated. Without the essential expertise, advancement can be frustratingly slow. Accordingly, developing and maintaining staff expertise should be a main concern.

By successfully overcoming the various challenges, many countries are now computerizing their cadastral records and creating large, national databases. Land-related databases are now being integrated, analyzed and distributed in ways that until recently were not possible. The computerized system will guide users through the work and thus minimize the possibility of any malpractice. Search of information will be very fast and efficient from the database. Modern GIS will create the possibility to produce print-outs, maps, forms, reports and statistics easily, accurately and fast.

The Land Register is often seen as one vital component of the Base Registers, which form the core for any Information Society (Kokkonen and Vahala 2002). The construction of national coverage of the fundamental data sets required to support a National Land Information System (NLIS) is a major long-term investment. However, experiences from the successful NLIS, for example, Sweden (CBRED 1995), show that the operation and maintenance of NLIS can be fully supported through cost recovery and can be commercially very successful once a critical mass of land-related database has been created.

5. Recommendations

Computerization, while an integral component of almost all land administration reforms, can be a high risk strategy if not introduced carefully (Suwarnarat et al. 2000). Importantly, land administration reform is not simply about introducing a geographic information system. While the introduction of appropriate technical solutions will be critical to the success of any land registration and administration project, technology is not an end in itself and must serve the overall objectives of the reform such as improving the operation of the land market or providing security of tenure (UN-FIG 1996).

An autonomous project-based organization, such as a special project team, is sometimes crucial to the success of any major GIS implementation. The project team need not be permanent because it can be disbanded when the GIS facility becomes operational. This approach is recommendable to the implementation of GIS for land registration in Ethiopia. Once the allocated project period is completed, permanent arrangements of staff and equipments should be made at the appropriate organization that would be responsible for maintaining the land registration. Without planning for a continuing investment in the long-term, most GIS will quickly become ruined (Bernhardsen 1999).

Managerial structures for implementing GIS is the most important organizational problem, followed by shortage of skilled staff. Better knowledge and information are liable to bring about a better understanding of a system and thus produce the possibility for better management. In addition, better management can bring considerable cost savings. Therefore, better management skills, better management education, and better management information are the essential components of management issues.

A computerized LIS is not an independent system. It has strong linkage with the external environment. Laws, customs and the administrative structure are very important to sustain its development. The LIS should aid in the sharing of data and improving data accessibility for a host of different land information users and organizations should avoid undesirable monopolization of information.

Therefore, by taking the above outlined issues into account, a detailed study should be made addressing all the concerns, and eventually lead to a successful implementation of GIS technology for rural land registration in Ethiopia.

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