

# **Low Cost Technologies and Techniques in Implementing Cadastral and Spatial Information Management Infrastructure**

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**Key words:** Land Administration, Cadastre, Spatial Data, Low Cost, Sustainability.

## **SUMMARY**

This paper examines technical and financial matters concerning the methods and technologies to be used for the implementation of cadastral and spatial data infrastructure. The cost and time involved in introducing computerized nation-wide land administration systems is considerably large and full implementation may take many years; data collection alone can be relatively expensive. This paper stresses the importance of cadastre and Spatial Information Management in the national economy; considers the costs and benefits of implementing and improving land administration systems and reviews the potential for using “low cost methods” for the implementation and “cost recovery” policies for the sustainability and operation of these systems, according to the local circumstances, needs, necessary quality and precision, and available budgets.

A research is made to collect recent international experience in the field, classify it and present it together with a proposal. The employment of high resolution satellite images, orthophotography derived from aerial and satellite images, photogrammetric techniques using simple hardware and sophisticated software, GPS techniques and Internet capabilities for multiple, wide range use of spatial data can reduce the overall cost. The combination of the above with better definition of the objectives and the customers’ needs, the necessary quality, the clear and scientific justification of the expected costs and benefits, the close, permanent coordination and follow up of the projects, the ability to manage the necessary changes whenever needed and the close cooperation between all those involved can provide more cost effective and excellent cost-benefit ratio alternatives.

# Low Cost Technologies and Techniques in Implementing Cadastral and Spatial Information Management Infrastructure

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## 1. THE IMPORTANCE OF LAND ADMINISTRATION SYSTEMS TO SUPPORT THE ECONOMIC NEEDS OF A COUNTRY

Several scientific publications in the field of Land administration have established that the land is the source of wealth. When governments attempt to develop trusted systems of land tenure and land transfer, they are in fact trying to create the tools to make the realization of that wealth possible. Trust among citizens, business and government is the foundation of the economic well-being. Where confidence is lacking in land tenure, no investment will be risked, no improvement will be made, no economic or social benefit will be achieved and disputes will arise.

Appropriate land administration / cadastral systems introduce land registration procedures that facilitate the regularization of informal settlements and simplify the land transactions, thus developing a land market. These formal property systems convert land property into capital by describing and organizing the most economically and socially useful aspects about real estates, preserving this information in recording systems and embodying them in a title. (de Soto, 2000)

Without such a system any trade in land requires an enormous effort just to determine the basics of the transaction: ownership rights, mortgage rights, restrictions on ownership, resolving of possible disputes, etc. In many countries the sale or lease of a house may involve lengthy and costly procedures, and considerations of “customary tenure”, thus restricting the land market to local circles of trading partners only.

In general, good Land Administration (LA) systems are important to serve to: guarantee the ownership and security of tenure, support the efficient land and property tax collection, provide security for credit and develop the mortgage market, develop and monitor the land market, reduce land disputes, facilitate transparent urban and rural land use control, increase investment and infrastructure development in urban land, improve the rental market system, improve agriculture in rural areas, support environmental resources management, protect state lands and produce statistical data (UN/ECE, 1996; UN/ECE, 2000; UN/FIG 1999)

The amount of transactions in property: selling - buying, leasing, renting, establishing user rights, mortgaging, etc has a profound impact on the national economy as well as on the economy of the individual citizen. (Onsrud, 2003). Today, the contribution of an active land market to the overall economic development is better appreciated than some years ago, but still is not greatly influencing the LA policies (policies about *ownership, value and use of land*) and projects.

## 2. “LOW COST” IN LAND ADMINISTRATION SYSTEMS

According to the international experience, the cost of building or even re-building, or reforming a national cadastre and a land title registration system, to serve as tool for good Land Administration, is considered to be an expensive process for almost any country. It requires large amounts of government funds, together with grants and loans from outside bodies. (Dale 2003, Manthorpe 2003). For various reasons, it seems that every attempt in that direction operates under great economic pressure, regardless of the prosperity level of a country. The situation becomes worse when it comes to countries with less developed economies and an emerging need to develop their land markets.

Several requirements have been made to identify more “cost effective” ways to improve the availability and accessibility of tools of land information (cadastral/spatial information) and to develop innovation and adaptation in simplifying these tools to fit the local situation. (Tibaijuka, 2002)

The target seems clear; what we mean when we talk about “cost effective” or “low cost” is: *good results within less time and low budget*. Yet the solution to the problem is complicated. Less time and low budget may encourage use of too-cheap equipment, or lower quality of work. The critical issue now becomes to define the necessary quality of the results by defining the present and the future needs of the project, to have a successful strategic plan, to achieve co-operation and future integration and upgrading.

Who will decide? Is it one of the new tasks in our profession and a new role for the surveyor to undertake in a changing environment? (FIG, 1996).

Is cost control supposed to focus on low cost equipment and technology, or is it a more complicated issue involving low cost procedures and results? Sometimes even an expensive tool, like a GPS receiver, might save overall costs. Today, almost all projects/agencies are facing the problem that much of the investment in technology of the 1990s is now obsolete (Foster, 1998). It needs to be replaced. Specialists in Land Administration are talking about the need for a “technology refresh” in all cadastral agencies (Dale, 2003).

But “Low cost technique” in implementing cadastral and spatial systems is only one “brick in the wall”. According to the international experience, the need for reducing the *time required* to accomplish any project is the most costly factor. Today labor is expensive and in order to accomplish low cost, the time of human labor must be minimized. But labor time may only be minimized while also achieving quality of production. A major component of efficient and proficient work is the concept of Quality Control/ Quality Assurance mechanisms.

Less time means less cost, but also means more productivity. To be able to finish an operation on time and to reduce time required for the next operation increases productivity. An agency increases its effectiveness in efficiency and accountability by delivering good quality of service (data and services that are fit for purpose and use) and by satisfying the customers’ needs.

This paper makes a research on the latest international experience on the “low-cost” issue, derived from the on-going land administration projects mainly in the region of Europe, but also in other parts of the world. An attempt is made to analyze and present important recommendations and new trends about, first, the “low cost” in the implementation of cadastral and spatial information systems, and second, the low operational cost and the “sustainability” of these systems. In addition some conclusions are derived on how the “low cost” issue should be addressed in future and a proposal for additional in-depth research in this field is given.

### **3. “LOW COST” IN IMPLEMENTING CADASTRAL SYSTEMS AND SPATIAL DATA INFRASTRUCTURE**

There are many factors that influence the cost of a LA project: the original design/ plan (concerning the setting of priorities and identification of customers’ needs, definition of the required results, justification of the necessary budgets), the technical approach (concerning the equipment and methods selected, the level of privatization), the legal approach (concerning the responsibilities and agencies and the adjudication of rights), institutional aspects (concerning cooperation between involved agencies and among other LA projects), organizational and operational issues (concerning the costs during the compilation period and good management and decision-making), supervision (concerning the progress and additional costs assessment and the flexibility to manage the changes), and political influence (concerning financial and administrative support, stability in LA policy). Some of the above factors will be addressed in the following.

#### **3.1 Cost-related Aspects concerning the Design of the Project and the Identification of the Needs**

In the initial stage of *designing a new land administration project* a number of serious aspects should be taken into consideration for the strategic plan, such as the awareness and assessment of the local situation and culture: the existing “system”, whether it is a land registry or a cadastral system, or a deeds system already in operation. The legal framework of statutory law referring to land issues, or even the customary tenure, should be taken into consideration. Also the on-going relevant projects should be of great importance.

It is of considerable value to identify the economically clear and tangible benefits, needs, targets, goals, objectives - not just those benefits that are theoretical- and use them as basis for the developing LA policy and the project. (Onsrud, 2003; Hernandez, 2003; Molen, 2003; Potsiou, 2003).

User representatives should be involved in identifying the needs and setting the priorities. Any initiative to change, improve or establish a new system should be well documented, according to the *needs*, the cost should be analytically estimated and a full, clear *justification for any investment in terms of benefits should be given* (Molen, 2003).

Attention should be paid to the fact that the way a system is structured, organized and monitored is more important for improved land management than whether it is a deed

registration system or a registration of titles system (Hernandez, 2003). The combination of a deeds system and a strong notary system for example may provide as much security as the combination of non-authentic documents with a title registration (Molen, 2003).

### 3.2 Cost-related Aspects concerning the Technical Approach

The implementation of a nation-wide land administration project requires a large investment of public money; its cost depends highly on the *size of the country* and the *technical approach selected*, that is, mainly the *precision of the survey data acquisition process*. Nation-wide projects are huge tasks and need continuity of financing, close coordination and close and permanent supervision concerning the progress assessment and the cost control. Usually, for nation-wide data collection the private sector has a big role to play in the compilation phase. Data may not be collected economically by the public sector employees. The required increase in staff, perhaps having lower performance capability and productivity, will no longer be needed at the end of the data collection phase of the project. The use of common and well-established methods and techniques should be chosen in the case of large projects where the commissioning of the work will be distributed to many small private companies either in small size contracts or sub-contracts, so that the required quality of the results will be better secured. New techniques should first be applied to pilot projects and results should be tested before their broad application and use.

Costs are very much linked to the level of ambition of the project in establishing the maps and the databases, the data collection phase. In some projects (Latin America) field surveys equal 70-80 % of the total cost (Hernandez, 2003), in the Hellenic Cadastre project the real cost for the spatial data collection represents 14% of the total cost. Yet, another 67% represents the cost for the collection and compilation of legal rights. For this reason optimal, cost effective technical options should be selected. Most of the times *some aspects of "quality", such as high accuracy and completion (content of detailed information) of the maps should be sacrificed (even though considered interesting)*, if they reduce the cost and the duration in such a proportion that makes the project feasible, ensuring the permanent support and financing until the entire national coverage is complete. (Hernandez, 2003). Although completeness of maps is a more important issue than the geodetic accuracy, maps do not need to be 100% complete. It is too costly to try to avoid all disputes concerning geometrical data over land. *Minimum requirements to maps and to data content of registers* to support sporadic transactions should be identified (Onsrud, 2003). Flexibility should be offered to the selection of the technical equipment and the method to be used for the data collection and quality prescriptions should focus more on the desirable accuracy of the results. (Potsiou et al, 2001). In the same concept of not focusing on excessive accuracy, it should be understood that the *existing stock of relevant spatial data should be used* and incorporated in the data collection stage, thus reducing the time and cost of the process.

It should be understood that in order for LA to help the economic development of a country, by enabling more investment on land, most important factor is to serve the land market by providing security and accountability in *high speed*. A critical defining measurement of good LA in each of the benefits mentioned in chapter 1 is speed (Foster, 2003). *Land markets work*

*well also in countries without complete and accurate maps and registers (examples are England, Norway). It is however essential to put in place uniform services to the public for handling sporadic cases i.e. sorting out the situation with the parties in the field only when it is necessary.*

“General boundaries”, or less accuracy in the boundary definition are acceptable in areas where the development of the landscape is mature as in urban areas and cultivated land areas, but attention should be paid that boundaries should not be uncertain or variable, so that they will not burden the development of land market and the investment procedures (Foster 2003) Taking into consideration that the appropriate scales for nation-wide Land Administration systems or spatial data collection are varied between 1:10000 and 1:1000, the alternative appropriate technical methods for this purpose could be:

- field surveying (either detailed field survey at the scales 1:1000-1:2000, or completions and updating, or just individual measurements of distances)
- GPS measurements (for the definition of control points or the boundary points)
- Photogrammetry (simple enlargement of airphotos as a very cheap solution, orthophotos or rectified photos, high resolution satellite images (IKONOS/Quick Bird) or orthophotos without GCP at scales of 1:10000, or with GCP from GPS at scales 1:5000 and 1:2500, DTM derived automatically from airphotos or satellite images, stereorestitutions from airphotos or satellite images at scales 1:1000-1:5000 or 1:2500-1:10000). It should be noticed that in the near future satellite images with pixel size less than 0.5m will be available satisfying the accuracy needs of such works.
- Existing stock of spatial data, maps (after the necessary quality control for the security of accuracy and completeness level)
- Combination of the above methods according to the specific needs. This alternative can be proved the most appropriate and can reduce the overall cost (Ioannidis, 2003)

Even the compilation of “index maps” from high resolution satellite images or on an orthophoto without GCP with accuracy of the scale of 1:10000 can provide an acceptable alternative when the main objective is to establish the land tenure and a working land market. Priorities for the areas under cadastral survey should be given to urban areas and to informal settlements before rural areas. It is necessary to facilitate first urban renewal and development and to improve the urban land market, so that economic progress will be more easily achieved.

Data processing and dissemination is also complicated.

Experience shows that best systems are developed when land registration/cadastral know-how and specialist computer expertise are brought together. But, Information Technology in-house step by step developments are proved to be costly and ineffective; especially in large projects IT services are usually contracted out. In general, integrated and sophisticated solutions are preferable and external long-term technical assistance is necessary. Then, the efficiency to manage and regulate performance will depend on the level of in-house expertise. (Manthorpe, 2003)

The increasing use of personal computers, Internet, electronic signatures, SDIs and new tools for data sharing like the OpenGIS, create a user demand for the development of an electronic land market. The e-land market accelerates the speed of the transactions, thus increasing the efficiency and the public acceptance of the system, while at the same time it serves for the considerable reduction of operational costs, through a reduction of the necessary number of branches, regional offices and employees. Governments, who are in the process to establish a new cadastral agency today, should think forward and consider this technical approach seriously before making decisions for the administrative and regional structure of the cadastral offices.

### **3.3 Cost-related Aspects concerning the Legal and Institutional Approach**

When the use of a mass adjudication process for the collection of legal rights is needed, an effort to limit the registration of objects to what is legally acceptable without creating new disputes is a key issue. A practical, quick and low cost solution to handle disputes, administratively and avoiding the judicial way should be established. The resolving of disputes should be carried out, outside the regular courts (UN/ECE 1996), through good organization and classification of the various dispute kinds (disputes referring to identity data, or geometrical data, or legal rights) and by introducing a compulsory stage for private negotiation (with the assistance of a minimum number of experts) prior to their examination by a committee. Despite the great attention paid and the fact that disputes were correctly planned to be solved outside regular courts, finally, much of the delay and cost increase of the Hellenic Cadastre project during the pilot phase was caused by the large number of disputes piled up immediately after the first suspension and to the time-consuming process for their resolution through the two level administrative-legal committees (Potsiou et al, 2000).

Coming to major institutional aspects, it must be noticed that Land Administration is a broad issue, with many different components (mapping, registration of rights, valuation, taxation, physical planning), where many agencies and organizations, even at ministerial level, are involved. Breaking down large nation-wide projects into smaller parts could be a realistic approach, yet appropriate harmonization should be ensured.

Institutional and responsibility arrangements between parties involved in the execution of a cadastral project, mainly between the two major agencies: cadastre and land registry, should be carefully made. Responsibilities should be clear also about the maintenance of the system and the services provided in future, so that cooperation and balance will be achieved with less effort. Initiatives for big institutional and organisational changes have created conflicts, which have hampered many projects. The time and cost demands for the negotiations and the legal procedures for the compilation of the legislative amendments to solve these conflicts should be avoided.

An amalgamation between cadastre and land registry agencies is usually not popular- after all they often have very different objectives and ways of looking at the world. Being “joint-up” does not, however, mean being in the same government agency; rather it means sharing data

and working to common goals. The key is cooperation and this has to be built into each agency's business plan (Dale, 2003).

Public-Public cooperation is necessary before any cadastral project starts. There is a need to survey all Land Administration projects under compilation at the same time and at the same place, so that duplication of effort, data collection and cost increases are avoided. There are several examples of good practice in that field (Miron, 2003)

#### **4. LOW OPERATIONAL COST, SUSTAINABILITY OF THE CADASTRAL SYSTEMS**

Much discussion is carried out during the last decade among experts and politicians about developing greater commercialisation and a business culture into the public sector, about the potential benefits of an upgraded role of the private sector, and about finding methods to establish cost-recovery policies into the cartographic and cadastral agencies.

Many reasons have led experts to those considerations: the increased need for funds due to the increased need for continuous technological updating, the restricted and unstable due to changing political and social reasons annual governmental funding, the emerging demand to meet the needs of their local customers in a rapidly changing environment, but also the need to serve new customers as well, like the developing countries and the countries in transition.

Yet, Land administration is considered to be a public good, where the state takes responsibility of the data and the services provided by the cadastral agencies. The state has the right to charge "fees" for these data and services. In general, the state has to keep the "fees" to an affordable level for all the citizens, but also some basic information should be available for free, since citizens have already paid taxes for such purposes. The weak and the poor should be also enabled to have access to the system. So, being a servant of the public and develop a business operational approach at the same time introduces somehow conflicting principles. "Fee" policies vary in the various countries.

Examples of good practice are given from western European agencies. The level of cost recoverability they can achieve varies from the primitive stage that the users pay for the cost of making the data available but not for the cost of their collection and updating, to a partial or even a full cost recovery. In this situation some of the fees come from central or local government through service agreements for the provision of data and services for a certain price; this is usually the case in the cartographic data provision agencies or cadastres. Transactions of land and legal rights can easier bring revenue from the individual users and thus these agencies can achieve a full cost recovery. In some cases, cadastral agencies have even managed to make profit through their activities. In agencies with most "trendy" managing policies, this profit is reinvested into the same agency so that new equipment are purchased, or specific research is made to improve services, methods and techniques (Welter, 2000).



Another way that, under good planning, may reduce operational costs is “cooperation and information sharing” between organizations and projects as mentioned above.

It is obvious that it will be very difficult for every cadastral agency to reach a stage of cost recovery. Yet, adopting a business approach may bring good results regarding the quality control and quality assurance issues. In many cases the objective or meaning of “sustainability” and “cost recoverability” should be improving the accountability and efficiency (Dale, 2003).

## 5. CONCLUSIONS - PROPOSALS

Reducing the costs in implementing cadastral and spatial information systems is a complicated issue. It depends on the tools and methods used, but also it is greatly influenced by factors like decision-making, identification of the needs, supervision and progress assessment, political influence, cultural issues, but also on education, experience and knowledge sharing.

In order to achieve more cost effective results in land administration projects, besides following the development of new surveying methods and technological achievements and testing the speed, cost and quality of their results, more systematic research should be done in other particular fields, too, such as: “surveying the user needs”, “estimating the user satisfaction”, “improving efficiency and proficiency”, “resolving legal issues more through by-laws, national standards and regulations rather than by official laws”, (Onsrud 2003), “raising awareness at a high political level”, “raising capacity building and education in land administration”, “measuring the impact of a project”, “estimating the cost of installation, maintenance and operation, but also the profitability and the economic benefits including quantitative economic figures”, “efficient supervision methods”, “the creation of new forms of land tenure and the integration of customary tenure arrangements in statutory law especially for the developing world”.

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