DESIGN OF SDI TO FACILITATE URBAN PLANNING AT LOCAL LEVEL

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ABSTRACT

Urban planning at local level is one of the important professions to affectively mange local issues like housing affordability, traffic congestion, crimes as well as global issues like pollution, global warming, environmental degradation etc. Being a multi disciplinary profession, urban planners and concerned decision makers relies heavily on appropriate and up to date information from different sources. However, in many cases, required information is difficult to collect and is in un-appropriate format leaving planners with two options: either to rely on available information or to collect it again by spending more resources both affecting quality of urban planning or better to say quality of our life.

Decision makers in different sectors started limited applications of modern Information and Communication Technologies (ICT) in the form of Geographical Information Systems (GIS) for spatial information management. But this traditional GIS was limited in spatial information sharing and its application in decision making and therefore, a new concept of Spatial Data Infrastructures (SDI) emerged for effective and efficient information sharing and its application in decision making. But so far, most of the work relating to SDI is theoretical and no standard technical model of SDI for different scenario is available yet. This paper is focused on exploring the design of information model for local SDI mainly from urban planning perspective. This design is based on Service Oriented Architecture (SOA) concept allowing replicable use of services between different users, professional and decision makers. It will lead to successful development of local SDI with principle of collect once and use many times.

Keywords Urban planning, SDI, GIS

INTRODUCTION

Urban proportion of the total world population has quadrupled in the last one century and is expected to grow more rapidly (UN, 2006). At the same time, urban problems and issues like housing affordability, traffic congestion, pollution, crime etc are increasing. Authorities responsible for urban planning & management are unable to perform their duties effectively and efficiently due to their own problems. Without solving their problems first, it is not expected that these authorities can create a better living environment.

Planning is a future oriented activity and is a means for preparing for actions. It occurs through a process in which: (1) information is collected and analysed; (2) logical alternatives courses of actions are developed consistent with the goals of a constituency; and (3) a course of action is recommended. (ASCE, 1986). Information collection, management and analysis about past trends and present issues is pre-requisite of good urban planning & management. The more information available about people's actual needs and preferences, the better planners are able to satisfy them (Dandekar, 1988). Mostly planners require data from secondary sources from national to local level. But in many cases and specially in developing countries, this secondary information is not easily available in appropriate form reducing its utility (Edralin, 1986). Therefore, planners spend a greater portion of their time and resources on data sources identification, collection and management while little time is left for analysis and policy formulation (Arbeit, 1993). Same data is collected by various department multiple times and in some cases similar data is collected by different departments simultaneously. Present approach of ad-hoc-ism in data collection at municipal level by various departments causing duplication and wastage of resources needs to be revised. Information must

be regarded as infrastructures and as local authorities can not afford to develop other infrastructure like water supply, sewerage etc again and again, than why is the case with information infrastructure (Carrera and Hoyt, 2006)? Currency of information is another issue as delay in information availability diminishes its values because ground realities changes very rapidly (Ouf, 2007). This lack of timely information in appropriate format is one of the major obstacles in effective urban planning and management (Cheema et al., 1993).

Having said this, this paper discusses information requirements of urban planners and decision makers at local level and how they are able to accomplish their demands in next section. It will highlight the complexity of issue and better understanding of how modern Information & Communication Technologies (ICT) in the form of Spatial Data Infrastructure (SDI) can provide a better solution. As SDI is an evolving concept and no detailed technical model is available for implementation, therefore a part of this model in the form of information viewpoint is presented in middle section of paper. However, as it is not a comprehensive one, so further research work and guidelines for more coordinated efforts are suggested in last section.

Information Requirement of Urban Planners at Local Level

Urban planning is practiced in one or other form since the beginning of human civilisation and it is hard to identify the exact evolution of modern urban planning. However from the end of 19th century, urban planning was recognized as a regular practice for cities management and their expansion (Salzano, 1999). In last one century, urban planning approach has evolved form static master planning to more flexible structure planning and action planning (Devas, 1993). As urban planning is perceived and exercised differently throughout the world, therefore, it is not any easy job to precisely define their requirements (Edralin, 1986). However, some of the common information requirements are highlighted in figure 1 (Kaiser et al., 1995, Edralin, 1986, Williams, 1968).

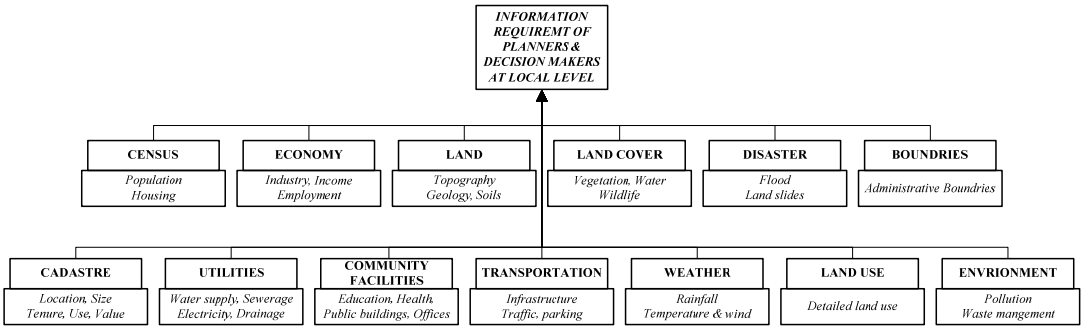

***Figure 1**: Information requirement of planners & decision makers at local level.*

One of the most critical information is about cadastre which forms the basis of many planning functions. Up to date cadastral information is pre-requisite for planning & development of land as well as for provision of infrastructure and services. It is required not only by planners but also by many other professionals involved in planning and management of resources at local level. People are also interested in it for tenure security. However in many developing countries, local authorities are unable to cope with higher demand of land registration process. This lack of good cadastral info is a serious constraint on the efficient city growth (Dowall and Clark, 1996).

Planning for the provision of housing and other services is based on the projection of population information already collected by censes organisation from time to time. Detail composition of population regarding age and sex is required for the provision of services like school, hospitals, parks and playgrounds etc. Similarly information about traffic, parking, and pollution guide planners in better managing existing development as well as planning new development by environment friendly sustainable policies.

Information required to urban planner is collected by different departments at different levels from national to local level. For example, cadastral information is managed at local/state level whereas topographical & geological information is managed by national survey and mapping agencies. Population and housing information required for planning & maintenance of utilities services & community facilities at local level is managed by census organisation at national level. This diversity in information collection, management, and its demand at different levels leads to un-coordinated practice of information sharing explored in next part.

Current Practices of Information Sharing and Issues

Value of information depends on how effectively and efficiently, it is used. Simple collection and storage of information is of no value, unless it is utilized (Rushton and Onsrud, 1995). Departments use / need information from other departments for their day to day activities. These activities can generate information which may be required by others. In these situations, these departments have double role as information user as well as information producer.

For example, census data is required by various departments like planning, utilities, economic / tax, emergency and by others services providers. At the same time, good quality base maps and land use maps prepared by these departments are valuable to census department. Similarly planning department needs information about cadastral, population, economy, transport, environment and utilities etc available in different departments but in return, this department can benefits from useful planning information in the form of various development plans, policies, land use maps and city growth patterns etc (Arbeit, 1993).

However, practically very little sharing in appropriate mechanism is made between different departments specially at local levels due to different reasons (Carrera and Hoyt, 2006). Most of the times, departments work with other departments with little coordination and rely on direct communication link between them. This isolated and uncoordinated complexity is highlighted in figure 2.

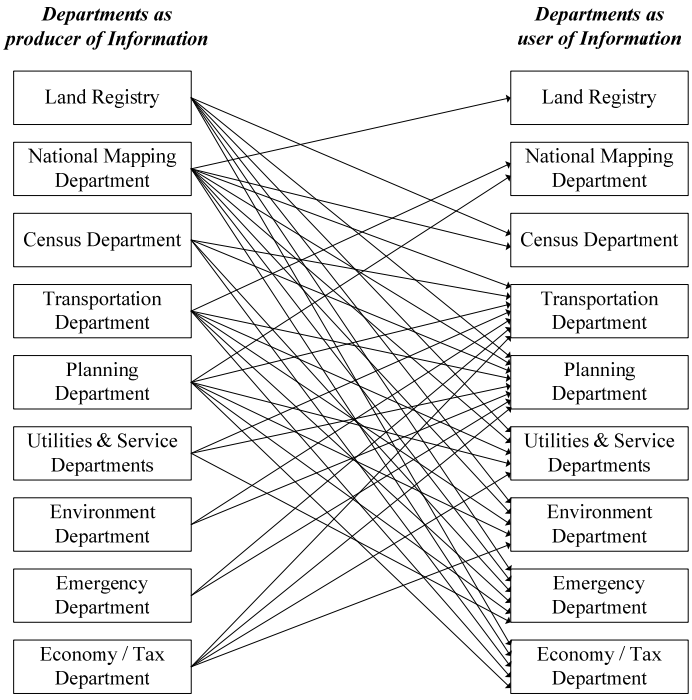

***Figure 2**: un-coordinated information sharing between different departments*

As a result of this uncoordinated style, sometimes departments are unaware of information availability within other departments and this ignorance leads to the duplication of data collection and management efforts. In certain situation, even if departments are aware of the availability of information, issues like aggregation of the available information, varying contents, standards, currency and absence of metadata reduces the utility of available information. There are cases where different departments are involved in collection of similar information (Carrera and Hoyt, 2006). Information must be regarded as infrastructure and as local departments can not afford to build other infrastructure like water supply, sewerage, roads etc again and again than why it is happening with information infrastructure? Planners spend a major portion of their time & resource on data collection, management and analysis. Improved sharing and application of available information in different department will not only save precious resource and time, rather it can help planners to spend more resource on better planning and management leading to an improved urban environment. Similar scenario can also be applied for other information hungry departments.

Situation where each department needs to coordinate with other department for required information leads to n(n-1) communication links where n is the number of departments. More links means more problems of information sharing. Increased coordination through the development of information sharing platform will reduce these communication links to 2n and can assist in reduced duplication of efforts, improved quality of available information with better accessibility and informed decision making.

OPPORTUNITIES FOR INFORMATION SHAIRNG & APPLICATION

Modern information & communication technologies have enabled us to build such an enabling platform and developed countries have started their efforts mainly at national level in the form of Spatial Data Infrastructure (SDI). But now experts have realised importance of local level SDI with large scale people relevant datasets acting as the basis for other levels of SDI. Involvement of many stakeholders at local level toughens the big task of the development of local SDI. Planners as information hungry professionals should come up & developed local SDI with main emphasis on their needs. Other professional can also coordinates and incorporates their needs leading to a full fledge local SDI development. But this papers main focus is on planner's needs & requirement and how SDI can be useful for them.

SPATIAL DATA INFRASTRUCTURE (SDI)

SDI as its name suggests is system of communication dealing with spatial data & information. Its main objective is better sharing and application of spatial information. Rajabifard (2002) describes SDI as an enabling platform based on dynamic, hierarchic concept with the aim of facilitating and coordinating the exchange and sharing of spatial information between different stakeholders and include data, people, standards, policy and access network represented in figure 3. It enables users to save resources, time and efforts by avoiding duplication of efforts related with information collection, maintenance and integration (Chan et al., 2001).

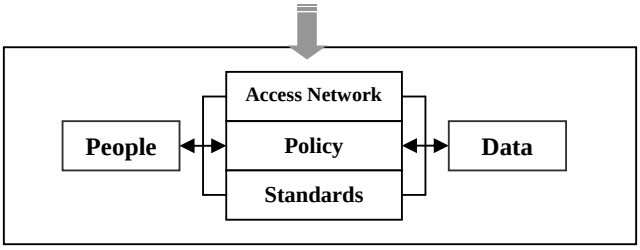

Figure 3: *Nature and relations between SDI components (Rajabifard et al., 2002)*

As information is collected and managed at different level. Therefore, a hierarchy of SDI is proposed by different researchers as represented in figure 4 (Rajabifard et al., 2000). These SDI at different levels are interrelated and are based on each other. Initial efforts started from national level, but now local & corporate level SDI with large scale, people relevant datasets are equally emphasised.

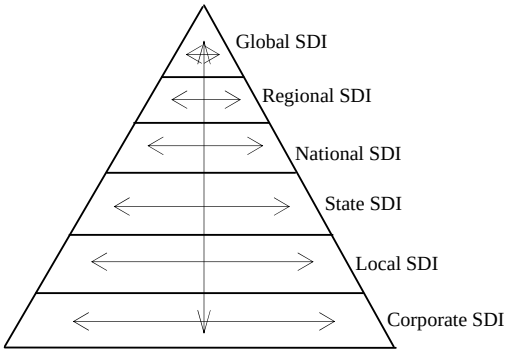

Figure 4*: Hierarchy of SDI (Rajabifard et al., 2000)*

SDI being an evolving concept is perceived and practiced differently throughout the world (Rajabifard et al., 2006). Initially the concept of information linking was promoted with concept of product based model. These SDIs were also referred as first generation of SDI. From 2000 onward, once developed countries completed first generation of national SDI, focus shifted to second generation SDI with process based model and their objective was to provide improved communication system enabling the community for sharing and using the information (Rajabifard et al., 2002).

Most of the work relating to local SDI is conceptual and so far limited practical work is done on technical design and development of SDI. Developing countries with limited expertise find it difficult to take full benefit in the absence of any design or model. Modern concept of distributing computing like Service Oriented Architecture (SOA) needs to be explored. Efforts have already started and some prototype application like fire damage assessment have been designed in developed countries (Friis-Christensen et al., 2007) and Commission on Spatial Data Standards of the International Cartographic Association (ICA) is also defining some models (Cooper et al., 2007) but still more design work is required.

Local SDI Design

SDI needs to incorporate the needs of all stakeholders making the design of SDI a multidimensional and complex job. Therefore, Commission on Spatial Data Standards of the International Cartographic Association (ICA) started to present SDI design at a general level. As the information is collected, managed by different department at different places, therefore various recent model in the filed of distributing computing were analysed and finally Reference Model of Open Distributing Computing (RM-ODP) was selected (Cooper et al., 2005). This model has the flexibility of emphasising different aspects of design in different viewpoints. A viewpoint is a subdivision of the specification of a complete system with some particular area of concern. RM-ODP is explained into five different viewpoint described below (Farooqui et al., 1995).

- Enterprise viewpoint
- Information viewpoint
- Computation viewpoint
- Engineering viewpoint
- Technology viewpoint

The enterprise viewpoint focuses on the purpose, scope and policies for the whole system. The information viewpoint emphasises on semantics of information and its processing. It illustrates the information managed by the system and the structure and content type of the supporting data. The computational viewpoint describes the functionality provided by the system and its functional decomposition. Mechanisms and functions required to support distributed interactions between objects & services in the system are described in engineering viewpoint. Finally implementation technology for processing, functionality and presentation of information in system is explained in technology viewpoint.

These separate viewpoints are not completely independent of each other; rather some key items are related with each other. Each viewpoint has its own importance, but as the objective of SDI is improved sharing and application of information, therefore information viewpoint attains more importance. Author's Professional background of urban planning helpful in better understanding of information/services requirements of planners is very useful in the designing of information viewpoint explored in next section.

With the development of 2nd generation of SDI, emphasis is shifting form simple sharing of data towards more advanced level of provision of services. Therefore Service Oriented Architecture (SOA) approach will be applied for the design of SDI.

Information Viewpoint

This viewpoint is based on the information requirement identified in the earlier section of this paper and presented in figure 1. It starts from the bottom with basic dataset available in different departments and ends at the top with advanced levels of services generated through geo-processing of information. ICA Commission on Spatial Data Standards has divided available data into four main categories of vector, raster, alphanumeric and multimedia (Cooper et al., 2005). But to make it simple and easy to understand, we have focused only on first three categories of data.

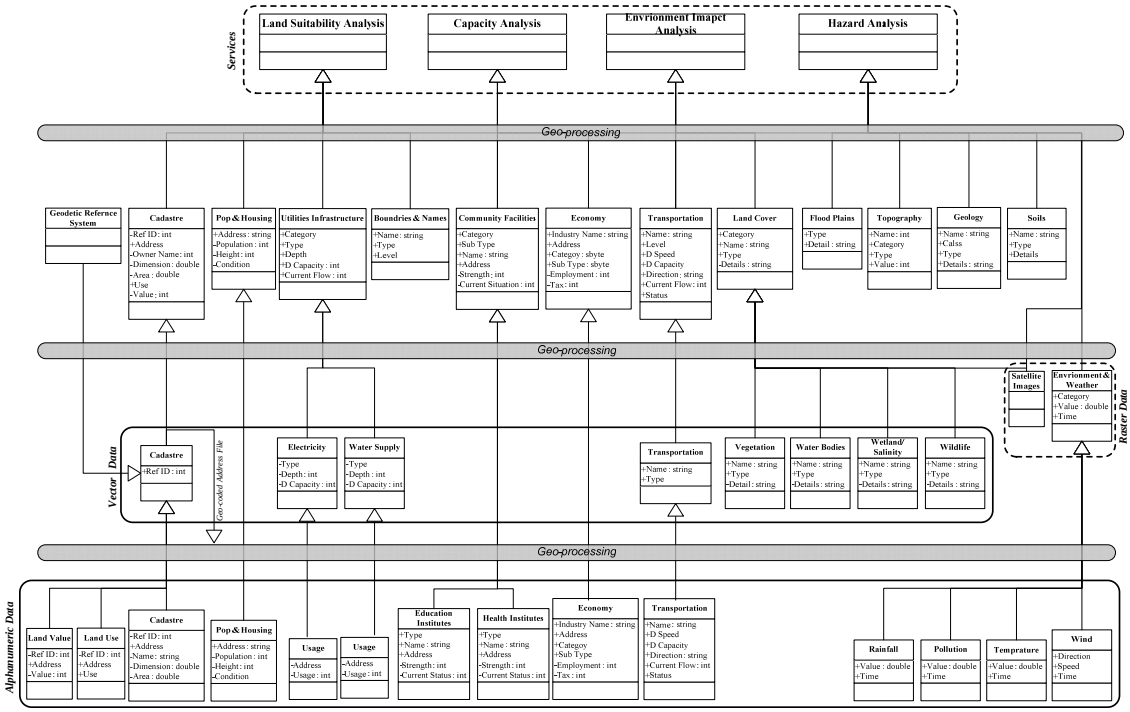

Figure5*: information Viewpoint of SDI from urban planning perspective*

Data can be available in printed or digital format. In case of Alphanumeric, it can be converted into digital format using simple database software with attributes defined in viewpoint. Whereas maps can be digitized manually or through automatic procedure using same geodetic reference system and incorporating required attributes. Satellite images or other interpolated data in raster format are expected to be in digital format.

Cadastral data comprise maps and registers. Maps describe the relative geometry and location whereas register include ownership, use and other valuable information. To integrate both datasets, a standard reference ID will be included in map as well as in register. This reference ID can be based on some serial number or coordinates of central point of cadastre. As different departments may be responsible for information about land use and value, therefore for that case, separate register for land-use and value are displayed. All these register will include standard reference ID and address beside other useful information. Address will be used to locate land parcel on ground as it may not be feasible to identify parcel using standard Reference ID. However, at time, address may be refined by different authorities and it may be difficult to integrate information, therefore, standard reference ID will form the basis of integration of cadastre. After incorporating register and vector maps, standard cadastral information can be generated by geo-processing. A standard geo-coded address file can be generated for geo-coding other alphanumeric information from different departments on address basis.

Data about population and housing, community facilities, economy etc can be geo-processed for overlay on other maps for better understanding and analysis. Only education and health are highlighted under community facilities but these will include all other community facilities like post offices, libraries, police station etc. Information about utilities infrastructure is critical to evaluate capacity analysis for new development. Normally this information is hard to obtain using traditional system. But geo-coding monthly usage of each utility service at parcel level and than geo-processing it with available network can assist us to find current status of their usage and future requirements. Data about weather like rainfall, temperature, wind and pollution is monitored at certain location and than interpolated for analysis. Standard geo-processing based on a uniform reference system and interpolation technique makes it really valuable. Otherwise different reference system and varying interpolation techniques means different users will be using different information. Standard image processing techniques can be used to explore different land covers information from satellite images.

Once required information is available, next step will be the development of services facilitating planners and decision makers for informed decision making. Some of the most common services or analyses are land suitability analysis, capacity analysis, environment impact analysis and hazard analysis. Land suitability analysis will be performed by evaluating feasibility of land for development by analysis topography, soils and geology information along with availability of infrastructure, related services and nature of land cover. Similarly hazard analysis can be performed by geo-processing land information, environment, transportation, flood plains with population and housing information. Once up-to-date required information is available in system, number of services can be developed by incorporating resource present in distributed computing system.

Other important components like metadata and services for discovery and retrieval are not described at this stage, but they will be the part of whole system and described later on as the design work continues. The purpose of presenting this simple viewpoint is to highlight the effectiveness of SDI in better information sharing and provide a starting point for more detailed design work.

CONCLUSION & RECOMMENDATIONS

Professionals and decision makers involved in urban planning / management need multidimensional secondary information from different organizations / departments. In developing countries particularly, current system is unable to meet these demands and therefore new platforms like SDI offering better opportunities for information sharing and application needs to be developed. But so far, no comprehensive model of SDI is available. This initial model of SDI in the form information viewpoint illustrates how information requirements and desired services can be achieved. It can be elaborated into more detailed and comprehensive design. It is expected that this systematic sharing & application of information through SDI will assist planners with better knowledge of current situation, improved awareness of available opportunities with constraints, impact analysis of their policies and better planning and policy making leading to improved urban environment. As planners are information hungry professionals, therefore, they should take initiative for SDI and start designing and development. Once they start work and other professional in different departments realize the benefits of SDI, than they can join together for the achievement of a spatially enabled society.

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