WebGIS enabling information sharing in local government

by Edward Kurwakumire, Tshwane University of Technology

Abstract

The information age requires citizens to be more involved in the town planning issues. Local authorities are facing challenges of effective planning and efficient service delivery to the public. At the same time, today’s public has evolved into information society powered people and have dynamic service needs. Information is central to the planning process and in service delivery but timely access is an issue in the Zimbabwean context. E-government initiatives are part of the measures that some governments have implemented to improve service delivery. Timely information is vital for planning and decision making for offering effective services to the citizenry. Geographic information systems have proven to be vital to planning in some European countries and within the United States even though most GIS literature has concentrated on the implementation failures. This study details the current work that has been done on geographic information sharing and the development of information access portals. Today’s information portals have a combination of similarities to distributed GIS systems and spatial data infrastructures (SDI) and hence the design considerations of a possible WebGIS platform are largely based on the SDI components. This study explains the role of GI in the operation of local government and its influence on public participation if widely available and accessible. The contribution of this study is towards the development of a larger spatial information infrastructure in which all local governments are interconnected, namely the SDI.

Key words

WebGIS, spatial data infrastructure, information sharing, local government

Introduction

Local governments have an obligation to serve the public by providing essential public goods that include basic information and services such as water and roads infrastructure. This is in the wake of the world advancing towards an increasingly connected information society [1]. The information society has thus become part of the drivers for local governments to implement information technology projects in order to keep abreast with the information demands from the public and the stakeholder network at large. Part of this has been realised to date through e-government implementations and electronic service delivery initiatives. Geographic information (GI) forms a key component to the operations of local governments as their services are to the public whose location in geographical space can be defined through locational information. GI is key in aiding the decision and policy making process and as such local authorities have been implementing localised geographic information systems (GIS) which can handle geographically referenced information. Recently there has been a shift in trends whereby the systems are becoming interconnected (distributed) and with access available remotely through web interfaces. This is the concept of WebGIS. Reasons for implementation differ from organisation to organisation. The most common include to improve efficiency and effectiveness in planning [2, 3], improve map making, develop workflow managements systems, offer digital data sets and offer electronic GI services and improve data dissemination and access [4].

There has been wide adoption of geographical information systems worldwide according to studies by [2,5,6] in their research of GIS in urban planning and local government. There is implementation of information infrastructures such as GIS and SDIs in African states according to [7-12]. Initial GIS implementations have been stand-ones motivated by the need to create digital spatial data sets as part of supporting a larger infrastructure namely, the spatial data infrastructure (SDI). Geographical information systems have now evolved from stand alone to networked systems allowing multiple users to access information. Currently they have further developed to web based systems namely WebGIS allowing real time remote access to information through the internet and multiple gadgets. The term geographical information is used synonymously with geodata and spatial data which is information referenced to the earth surfaces which forms part of the information infrastructure that today’s economies [13]. Local government is used to refer to local authorities or municipalities.

The rest of the paper is structured as follows: Section 1 and 2 detail the role and implications of adoption and use of GIS and related technologies in local government and planning. Sections 3 details some design issues that have been introduced in the transition from desktop to distributed applications. A brief discussion is presented in section 4 and the conclusions in section 5.
Background

There has been wide interest in deploying GI services online and this has been motivated by the advent of the internet [16] and by the improved availability of information and communication technologies. However, as ICT is becoming more accessible to some, the digital divide is also widening when comparison is made with respect to people with and without access to ICT [17]. Today’s society can viewed as an information society [1] in which government, industry and the public all thrive on information. The public also wishes to access information and other services online and this has brought forth e-commerce and related applications. Within the geo-information (GI) sector, the need to disseminate and access spatial data and services online has brought interest in studies within geo-portals [16], internet GIS, WebGIS and spatial data infrastructures (SDI). The development of internet and geospatial technologies has led the development of SDIs [18]. This spatial information plays an important role in town planning and as such is crucial in local government. The modern citizen wants to be involved in the city planning to shift the planning from being local government oriented to a collaborative effort in which different stakeholders including the public are involved.

Problem context

City of Gweru (CoG) and City of Mutare (CoM), are Zimbabwean municipalities where information sharing is impeded due to manual and analogue information access and sharing methods [14]. A similar case exists at Surveyor General’s Department (DSG) [15] and digital countrywide datasets are still yet to be developed. This information is based on surveys carried out at CoM, in 2007, CoG in 2012 and the DSG in 2012. Zimbabwe has ten major municipalities representing which all are running on manual systems (see Table 1) in as far as town planning and cadastral transactions are concerned. Gweru and Mutare are part of these nine major municipalities. The manual systems present inefficiencies, lengthy transaction times, poor planning and low response rates to emergencies and incidents. Citizens are not able to participate actively in spatial planning and in the town planning process due to lack of adequate access to planning information. Information sharing is not only a problem outside the organisation but also within the municipalities as different departments often want to utilize the same hard copy maps at the same time. There is need to develop an on-line environment that can serve the internal and external GI users and facilitate optimal sharing of information in real time. A web based GIS allows interdepartmental as well as inter-organisational data sharing with a facility for public access to information. This study puts into perspective some developments that have occurred within GIS literature in as far as systems developments and availability and access to information is concerned.

<table>
<thead>
<tr>
<th>Name of municipality</th>
<th>Status of cadastral system</th>
<th>Status of town planning system</th>
<th>Availability of website</th>
<th>Availability of planning information on website</th>
<th>Availability of spatial data sets on website</th>
<th>E-services</th>
<th>Availability of automated billing system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harare</td>
<td>Manual</td>
<td>Manual</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Bulawayo</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Gweru</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Mutare</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Masvingo</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chitungwiza</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Kadoma</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Kwekwe</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Marondera</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Chinhoyi</td>
<td>Manual</td>
<td>Manual</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1: Automation status of municipalities.

GIS in local governments

Geographical information systems (GIS) are being implemented in the public sector because of their potential in supporting planning and decision making according to [2,19,20]. Prior research also discusses the promises of GIS such as efficient management of data [21], information reuse [7] and in public policy implementation [19]. As a result of these promises, geographical information systems and related technologies have been widely adopted in Europe [5], the United States [2, 6] and Africa [7, 22] within the public sector. Public sector organisations have mandates to deliver public services to the local communities they serve and this has fostered many e-government implementations [1]. The intent of e-government is on improving governance through electronic service delivery to citizens and the creation of one-stop shops. Citizens on the other hand, are also able to take a more active role in participating in planning and public policy formulation [23]. GIS is one enabling technology that has been widely adopted in the public sector in order to improve government through improved service delivery. The integration of GIS with communication networks
across governments then forms part of the components of the electronic government infrastructure, but one handling spatial data.

Sawicki and Craig [4] discuss the participation of community groups in policy formulation through collaboration with planning officers. The authors argue that information technology can enhance participation of community groups in policy as information becomes more available. ICT is viewed as giving rise to electronic data which facilitates increased access to data. This increased access and availability is the democratisation of data. Pickles [24] views GIS as opening virtual spaces for social interaction and creating new communities of dialogue. As a result, GIS is viewed as a potential liberator towards democratic access to data or a technology that facilitates equal access to information.

Gillespie [25, 26] focuses on organisational efficiency and effectiveness as the benefits of having land information systems. Efficiency benefits are realised when a task can be done faster with the introduction of the GIS while effectiveness benefits are realised when the quality of the current output has been improved [25]. Tulloch and Epstein [3] identify efficiency, effectiveness and equity as the benefits accruing from use of GIS. The last stage of the benefits is equity in which democratisation is achieved though citizen empowerment derived from access to information. However, [3] argue that governments are more concerned with how the system will serve the agency rather than on products which can be realised by the broader community. This has been the case with spatial data infrastructures in which the development has been focused on the end user requirements whilst user requirements are crucial to successful adoption. GIS is also attracting attention in policy within public administration as it has already spread in many areas within the public administration [19, 27] as a result of their perceived usefulness in public policy formulation. The mentioned benefits can be summarised as improved availability and access to information which leads to democratisation of information [4].

WebGIS enabling to sharing GI

A WebGIS is an internet based GIS application which allows spatial data to be viewed and manipulated over an internet browser. The data in essence is stored in a database and is deployed to a geoserver for access by different entities at the same time. The WebGIS application requires fundamental or framework data sets data sets to serve as the base data. Fundamental data can be defined as the basic or core data sets which are the basis or creating other bundled and integrated information products [28] and includes cadastral, roads, administrative boundaries and topography data sets [29]. Such data could be taped from a functional SDI, local authorities in Zimbabwe are still operating on analogue systems in as a far as the cadastral system and the town planning process is concerned. The SDI is an infrastructure which enables efficient and effective access to GI and services by a variety of users [13]. It coordinates the production, discovery and use of GI in a digital environment [18]. However, Zimbabwe does not have a functional SDI as the potential stakeholders are dependent on largely manual systems with undefined information sharing practices. There is no legislation governing the implementation and management of the SDI. There is also no system for discovering the data sets that exist in different organisations and of making them available. The intention of this study is to give insight into the development of a successful WebGIS applications through identifying factors that need to be considered as part of a broader study to the development of an SDI.

Related work

De Longueville [30] discusses the Web 2.0 concepts and views geo-portals as “the most visible part of the SDI” as this is where users interact with the system. Web 2.0 concept ensures modularity in the design of geo-portals and webGIS systems while it also has a social dimension attached to it. In this regard, instead of the system being a one way street whereby users only access data that is on the system, users can also interact with the system to generate their own content. Different users can also better network and share information [30]. This enhances value to GI as information is reused and inconsistencies identified and corrected. However, ensuring a similar standard of quality on user generated content may present a challenge. A good characteristic of the Web 2.0 concept is that the system is implemented in a society and should interact with the users as described in the social construction of technology detailed in [31].

Van Loenen et al [13] assesses correlation between the use of geopotals for information dissemination and the value realised by users as a result of use. The assessment was to determine whether users benefit and perceive value from use of geopotals as access points for geographic information. Geopotals should demonstrate the concept of one-stop-shops for the users while reducing the transaction costs as much as possible. This requires geopotals to be efficient in discovering, delivery and exchange of GI by a wide range of users.

Kurworkumire [14] details the cadastral process and information sharing mechanisms at City of Mutare which has largely manual cadastral and town planning processes. Automation of the cadastre and the development of a data warehouse are suggested as a solution to improved data storage, backup, availability and access. Kurworkumire [14] suggests that the surveying department develops and maintains the digital cadastre as most key information comes from cadastral and land surveys it carries out. The rest of the departments within CoM should have access privileges to use and exchange data from the data warehouse.
SDI development has relied on the assumptions that formal organisations produce and supply GI while users are passive consumers of information [18]. On the contrary, with volunteered geographic information (VGI) it is the users who are the producers of GI. This creates some middle ground between SDI and VGI concepts as future system development can be a hybrid of the two. The advent of Web 2.0 has enabled the public to produce, share and exchange geographic information over the internet. Web 2.0 based geospatial activities reflect growing interest by the GI user community in being active rather than passive GI users. Within the VGI context, the user is not a passive one but rather one who is also a producer and supplier of GI hence adding value to the system. From a research point of view VGI has been more successful in attracting more users than SDI. Users are also willing to share information within VGI while there is reluctance within the SDI context. User centeredness partly contributes to these differences [18].

| Website development | General website for the local government office for providing public information and metadata  
|                     | Web interface for the application which is simple, interactive and easy to use |
| Technical considerations (hardware and software) | Hardware: Computers, peripherals, networking devices, servers, power Supplies  
|                     | Software: Operating system, QGIS, Geoserver, PostgreSQL, PostGIS, Apache  
|                     | Other internet applications: Google maps, Open Street maps |
| Organisational issues | Resistance to change  
|                     | Organisational culture change program  
|                     | Staff training |
| Information access protocols | Free access to information  
|                     | Paid access to Information  
|                     | Licence types  
|                     | Copyright agreements |
| Standards | Standards governing systems development for example, OGC standards  
| | Standards governing the quality of data  
| | Standard governing the format and what constitutes metadata |
| Metadata | A metadata catalogue should be compiled which details who has what data and the data characteristics |
| Data discovery | There is need for a data discovery mechanism which resembles a clearinghouse from SDI terminology |
| Security | Login profiles |
| Business process reengineering | Re-engineer the cadastral and town planning business processes |

Table 2: WebGIS design considerations

Discussion

Today’s public wants to be more active in planning and thus the systems in use should also be centered to public use [4, 23]. The webGIS application should not only serve the organisational mandates of the local government office but should be focused on the information and service needs of the stakeholders. The application should partly fulfil the role of the SDI of making geographic information more available and accessible [13]. The broader contribution of this study is towards the development of a national spatial data infrastructure (NSDI) for Zimbabwe. The WebGIS should support participation in planning and democratisation of public sector information (PSI).

Within the Zimbabwean context as depicted in Table 1, there is a need to migrate from manual to digital systems for both the cadastral and planning process. This requires re-engineering of the town planning and cadastral business processes (see Table 2) so that automation will bring some efficiency and effectiveness in the production and delivering of spatial data and services to the both intermediate and end users. This re-engineering should incorporate the WebGIS as the central access or dissemination point of both spatial data and electronic services. An automated system coupled with a WebGIS application should in principle improve availability of information as information can be accessed remotely from any internet access point. This wide coverage cannot however be met due to the digital divide, but there should be improvement in sharing and exchange of information by different stakeholders. The WebGIS, like any other application needs to be maintained and managed to ensure its success. In actual fact, the WebGIS is an information infrastructure that makes public information available to different users. Successful implementation and use can
improve the economic activity of the city through promoting real estate and tourism activities, thus leading to the betterment of society. Stakeholders such as utility companies can reuse GI to improve their public service delivery.

**Conclusions**

This study does not attempt to reengineer the business processes within planning by local governments or to develop a web portal to serve as an information sharing point. However, the intent is to highlight some design issues that can ensure a successful design and implementation based on experiences from SDI, WebGIS, and distributed GIS literature. At this juncture, there is no need to reinvent the wheel, but merely to analyse and improve on the technical and social deficiencies of other systems that are in use today with the intention of developing best practices in system development and implementation. The development of a WebGIS application is not a simple and clear cut procedure. The WebGIS itself is a complex system as it interacts with several entities within and outside the organisation. These entities form the stakeholder network. A successful implementation requires insight and consideration of social, technical and organisational issues. There is a need to clearly define the user requirements and ensure that the system is user centered which enables optimal use of the system. Several issues come with data access such as licensing and copyright and such agreements need to be clearly defined. The WebGIS system should be dynamic rather than static in order to continually meet and support the needs of the users. The system capabilities should transform users from passive to active ones as they also supply and add value to GI through an interactive WebGIS which incorporates the VGI aspect. The WebGIS application should be extensible and interoperable with other systems in existence in order to easily communicate and integrate individual systems into a robust integrated structure. The development of WebGIS applications is not an end in itself, but a means to the development of functional systems for use by local governments which support the requirements of today’s information society. From a town planning point of view, the application should be usable as a tool for collaborative planning while enhancing awareness and opportunities for the public to participate in public issues concerning the city and government. Local governments can then be able to consult effectively with stakeholders and gain feedback that aids in town planning.

**References**


Contact Edward Kurwakumire, Tshwane University of Technology, Tel 012 382-5086, kurwakumirree@tut.ac.za