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Developing a Web Based Integrated Land Information System for Ownership, Value and Taxation: Case Study of the Ministry of Lands, Housing and Urban Development, Kenya

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Abstract: ***Over the years, the Ministry of Lands, Housing and Urban Development in Kenya has relied on paper-based systems to discharge its mandate to citizens, a scenario that has generated millions of paper records both at the headquarters and the field offices distributed country-wide. The numerous records generated by the various Departments have posed a great challenge and difficulty in effectively referring to records and timely retrieval to serve citizens, institutions and other key stake-holders. As a result, the entire process has become inefficient, time consuming, unreliable, restrictive, redundant and costly, undermining efficiency and effectiveness in service delivery. A timely solution is through the establishment of an integrated, transparent, decentralized, affordable andefficient GIS-based Land Information Management System.The main objective of the study was to develop a web-based land information management system with an aim of providing a proper land information collection, storage and dissemination platform for the Ministry of Lands, Housing and Urban Development. The system is composed of three subcomponents: a single database, web-based mapping component and a website. The database provided is centralized, mapping component provides tools for data updating and visualization while the website hosts the mapping component and also provides additional information related to land management. The system contained information on parcel ownership, land use, taxation, location boundaries, land value, encumbrances and many more. The system offers a streamlined flow of land information within the Ministry ensuring there is well structured process of collecting, storing and disseminating land information. Implications of the system for the Ministry include serving as a platform to integrate data and facilitate data exchange in the Directorates; enable quick decision-making; facilitate and enhance analysis for land use planning; and act as a tool for improving public service.***

Keywords: Land Information Management System, Geographic Information Systems, Integrated Systems, Web GIS

1. Introduction

The Core mandate of the Ministry of Lands, Housing and Urban Development in Kenya is to manage and administer the land resource in Kenya. The Ministry's effectiveness and efficiency in discharging quality services to Citizens through improved processes remain key in this era of Public Sector Reforms, implementation of the provisions of the New Constitution, the National Land Policy Sessional Paper No.3 of 2009 and the radical paradigm shift towards achieving the Kenya Vision 2030 initiative.

The processes of administering and managing Land over the last over 100 years has mainly relied on a paper-based manual system. The hundreds of records generated by the technical departments have since posed a great challenge, and unbearable to effectively refer to records and timely retrieval while serving citizens, institutions and other key stake-holders. As a result, the entire process has become inefficient, time consuming, unreliable, restrictive, occasioned repetitiveness, unaccountable and costly, undermining efficiency and effectiveness in service delivery.

In order to address these daunting challenges the Ministry embarked on the effort to computerize its functions. The National Land Information Management System (NLIMS) was conceived in the year 2008 as the solution. The NLIMS aims at converting the existing land records into digital records that will be used electronically while the paper records are stored into an archive. The electronic records will be used in day to day transactions, while the archive records are preserved and will only be used as reference records.

Voluminous data on land use are collected, created, and used an integrated information system could help organize, store, and process these data for easy access, analysis, and dissemination. Concurrently, NLIMS also aims at re-engineering the Ministry Business Processes that are that were put into operations over 100 years, and hence achieve simplified, harmonized, effective and efficient processes that are sustainable within the framework of the Ministry strategic plan2008-2012, and the Kenya Vision 2030 initiative.

The general objective was to make geographic data available to the public and to specific end-users by developing an integrated web based land information that integrates land information and provides improved access and retrieval for multiple user categories. It will be used by the Ministry staff and the public with relative ease for spatial query, visualization, efficient updating and processing land parcels records. The specific project objectives being to establish the current status of land survey, planning and registration workflow and integration and state of LIS; integrate land survey, planning and registration information and develop a web based platform that facilitates user access and data retrieval.

2. Study Area

The case study area is within Nairobi County, Westlands constituency, topo-cadastral sheet Index Number 36-III-EG-68-1.

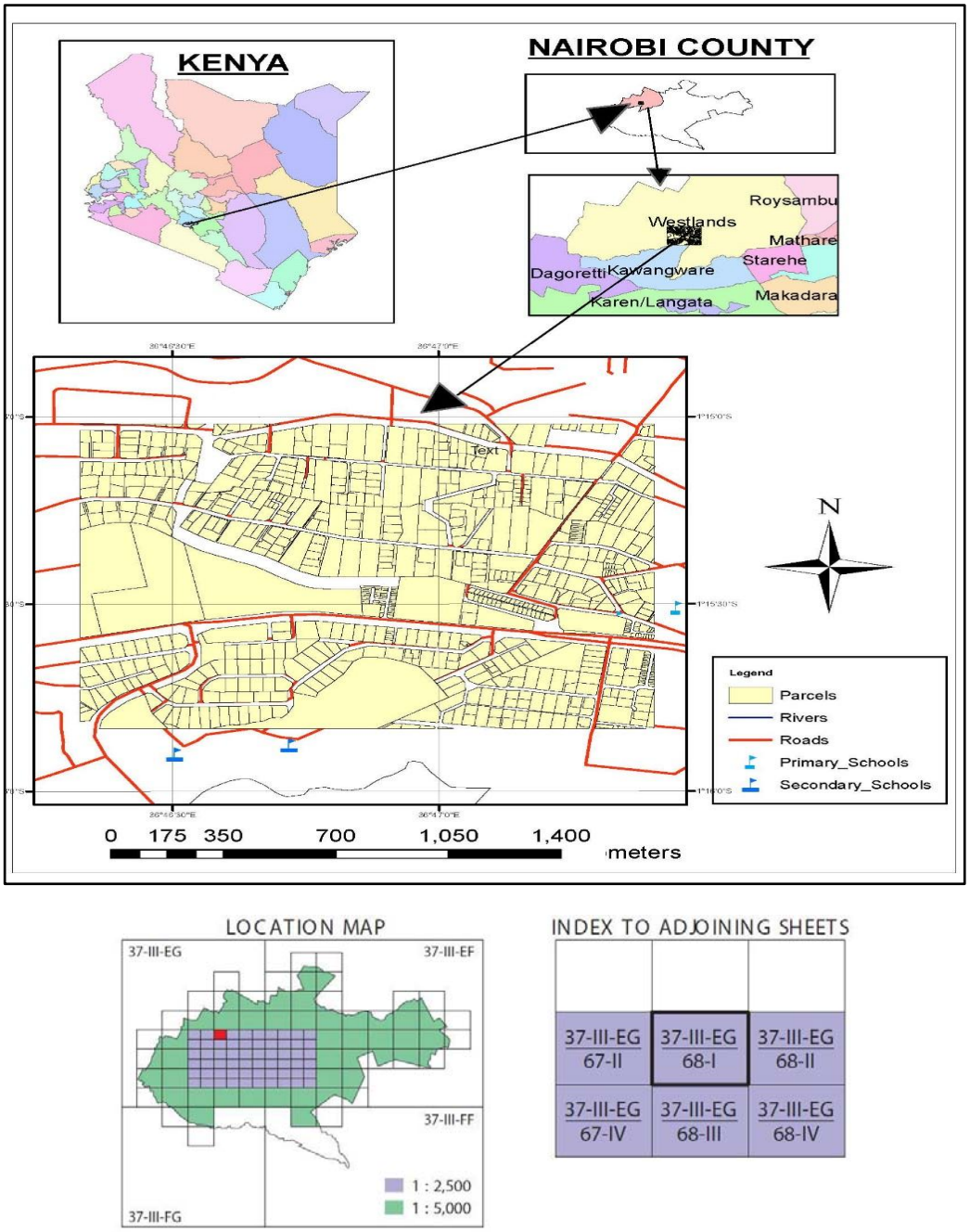

Figure 1: Study Area

3. Methodology

3.1 User Need Evaluation

The approach taken to achieve the set objectives involved carrying several steps: user need evaluation and data collection, data processing, system development and system implementation. The first phase involved user need evaluation and then the collection of relevant data as per system user need evaluation. Primary data collection was based on the administration of questionnaires with the key respondents who were classified into;Ministry staff and, Clients. The Ministry staff were further categorized into the three with respect to Departments namely; Lands, Survey and, Physical Planning. A total of 75 respondents were interviewed.

Table 1: Interview Respondents

Type	Number
Lands Department Staff	15
Survey Department Staff	15
Physical Planning Department Staff	15
Clients	30
Total	75

3.2 Data Collection

The data was obtained from various organizations dealing with the land resource. The data was in different formats depending on the type of data and the source or organization from which the data was obtained. This included the collection of the topo-cadastral maps and shape files of various features in the study area, including: Transport network (both main roads and minor access roads), Cadastral subdivisions, Existing buildings, Rivers, Location Boundary, Points of interest e.g. schools, major buildings.

Moreover, the non-spatial data was obtained from the Ministry of Lands, Housing and Urban Development records and also from field work carried out in the study area. This included:Land owner, Present land use, Present land value, Leasehold, Encumbrance, Tax charged, Tax arrears, Information on buildings i.e. its type (permanent or semi-permanent).

3.3 Data Processing

To process the data, Quantum GIS software will be used. The processed data was then be imported into Postgre SQL database. This process involved the scanning of the topo-cadastral maps obtained and vectorizing the required features and then saved as shape files in Quantum GIS software and each layer's projection was defined.

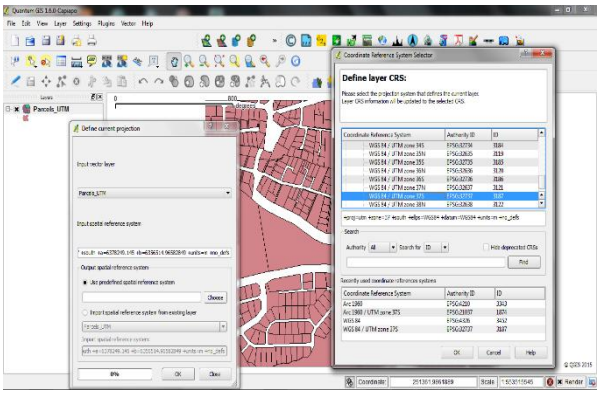

Figure 2: Defining projection for the shapefiles

Attribute data entry was done for specific layers using the non-spatial data collected. This was done for the land parcel layer and repeated for all other layers.

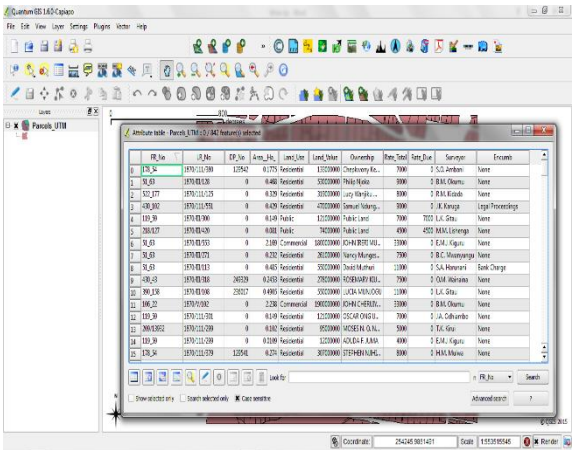

Figure 3: Attribute entry

After final area of interest map creation, the layers which required a creation of a database were connected to the PostGIS database in Postgre SQL. This was carried out in Quantum GIS by creating connections as illustrated.

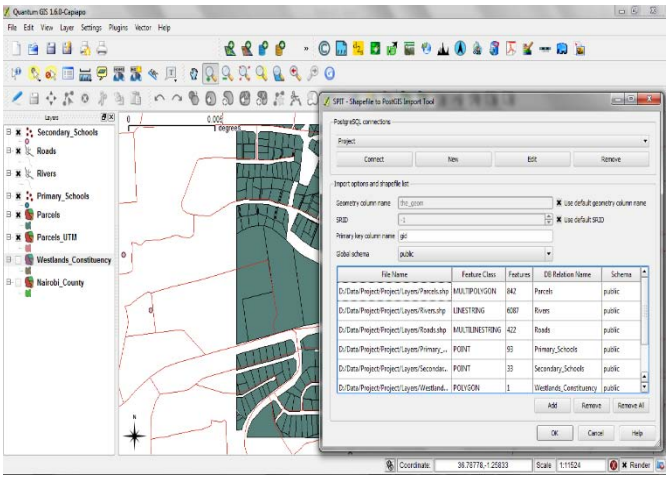

Figure 4: Connecting to the database

The various layers connected to the PostgreSQL database were subsequently added to Quantum GIS as Postgis layers. Once the layers were connected to the database, by using the map export function in Quantum GIS a Mapfile was created which was then used in the development of the system using the Geonode application. This is illustrated below:

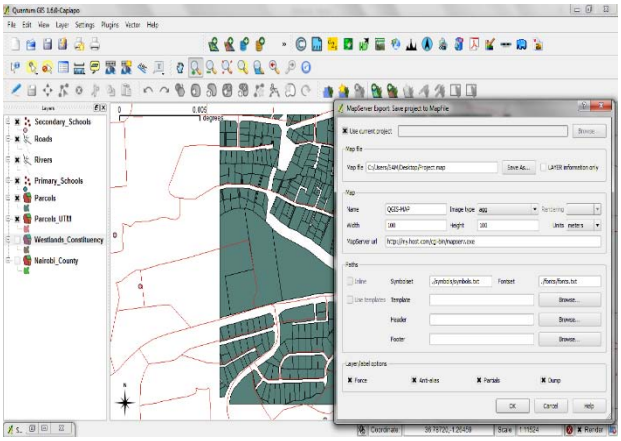

Figure 5: Creating a Mapfile

3.4 System Development

3.4.1 Database Design

Postgresql spatial database with its PostGIS spatial extension proved sufficient in holding spatial and attributive data derived from shapefiles. Pgadmin3 package was useful in administering the database, managing users and deriving SQL syntax.

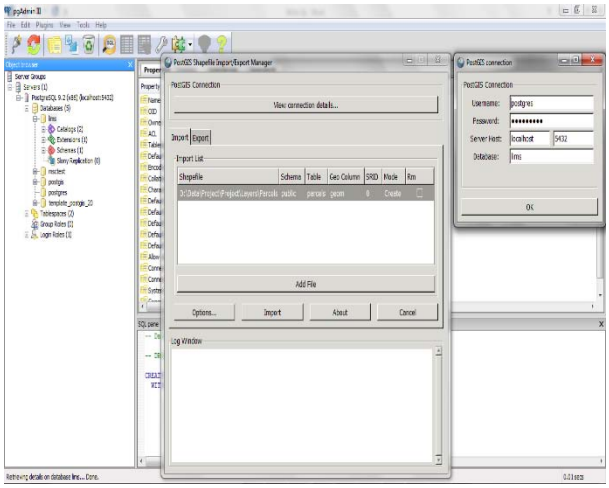

Figure 6: Postgis Shapefile Import

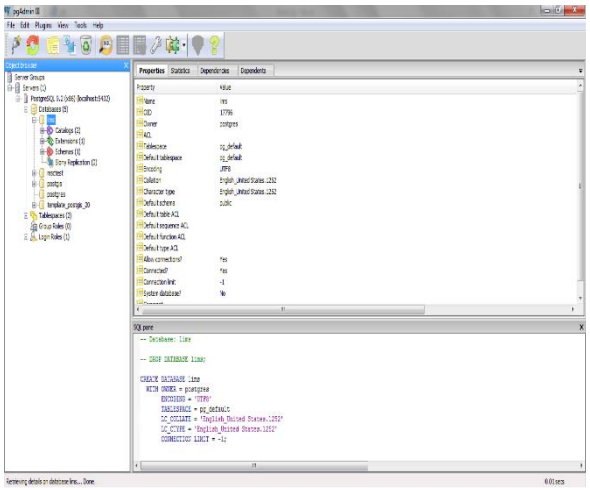

Figure 7: Pgadmin3, Shp2pgsql-gui and Pgadmin query viewer

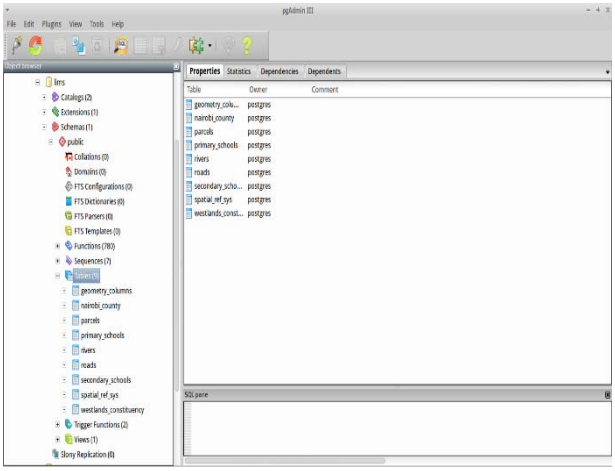

Figure 8: Database of the system including tables of land parcels, rivers, roads and features of interest

3.4.2 Application Development

This involved the design and the creation of the application that was to be used in the LIS whereby the mapfile created in the Quantum GIS was used as the base and this was achieved by use of the Geonode Application and using the PHP scripts and Java scripts to a add functionality to the application.

3.4.2.1 Application Server

The raw data is to be accessed using web services and rendered into cartographic products. GeoServer web map/feature server was selected as it does an excellent job of responding to WMS/WFS requests. Both operations are standardized by OGC specifications. The other alternative to GeoServer is MapServer which however has complex configuration issues and requires consistent editing of map files, an activity not necessary with GeoServer.

3.4.2.2 Application Cache

GeoWebCache tile cache was installed to enable caching of map tiles generated by GeoServer. Caching is essential for better user interaction with the Web GIS.

3.4.2.3 User Interface Framework

User interfaces including an interactive map viewer and forms are generated by Javascript libraries such as OpenLayers, ExtJS and GeoExt. These libraries are freely available and their installation simply involved placing a link on a HTML document referring to their locations in the file system.

3.4.3 Website Development

A web page was created using PHP scripts, Html and Macromedia Dreamweaver softwares where by the graphical user interface of the Land Information System was designed. This would provide the users with the information about the system and also access levels to the system.

3.5 System Implementation

The last step of the methodology involved testing the system on a network. It included identifying a server to host the system necessitating obtaining of the domain name. This will enable evaluation of the various features of the prototype against the user needs

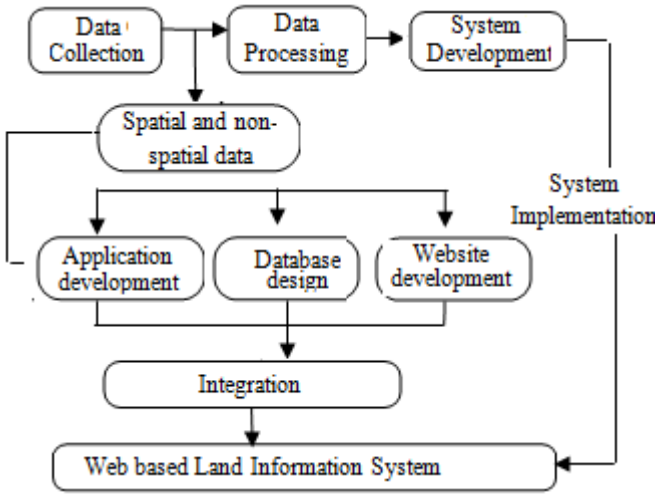

Figure 9: Work flow diagram

4. Results and Discussion

4.1 Staff Questionnaire Results

4.1.1 Current Status

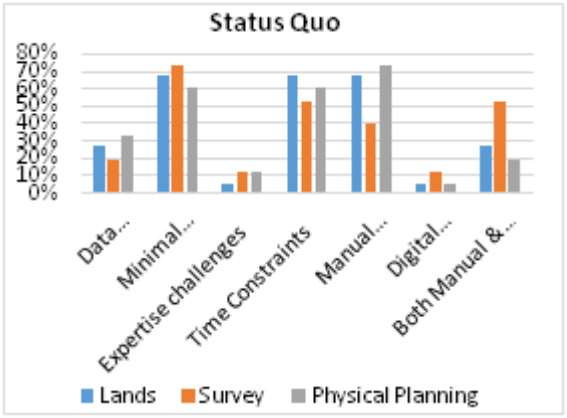

Figure 10: Staff response on Current status

In spite of some progresses in infrastructure development in Land Information System, development is still in theinitial stages. Lack of adequate technological resources and data inaccessibility are some of the barriers in hindering land information system implementation with the effect being highest in the Survey Department. In all departments most services are disseminated manually with the Physical Planning Department offering most services manually as illustrated above.

4.1.2 Need for Information System

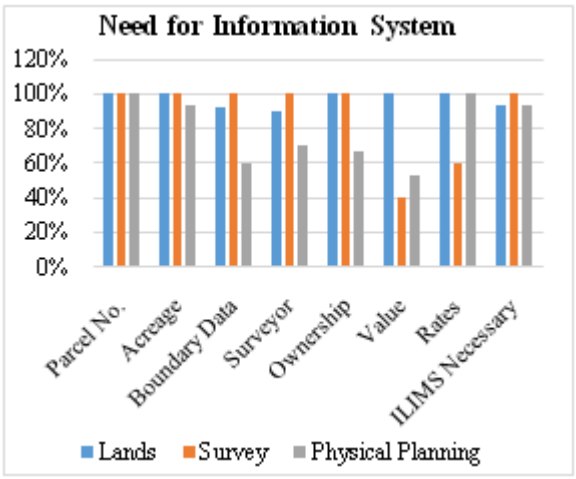

Figure 11: Staff response on Need for Information System

In all Departments it was noted that the need for Parcel Number Information, Acreage and Integrated Land Information System is common. However information on Boundary data, Surveyor, Ownership Value and rates varied from department to department depending on the nature of their work. Boundary data and Surveyor information was required mostly in the Survey Department while information on Value and Rates was mostly required in the Lands Department.

4.1.3 System Requirements

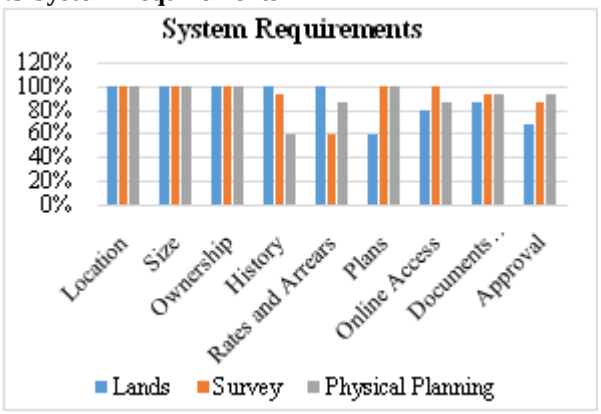

Figure 12: Staff response on System Requirements

With regard to the functionalities that the information system should be to provide Location, Size and Ownership were the most required across all the Departments at 100%. Land history was a minimal requirement in the Physical Planning Department while Approval was highest in the Physical Planning Department with 93%. Rates and Arrears was highest in the Lands Department and this can be attributed to the nature of work which mostly includes rates assessment. Requirement for generation of Plans was highest in the Survey and Physical Planning Department which can also be attributed to the nature of work whereby maps are the main data type sought.

4.2 Client Questionnaire Results

4.2.1 Services Required

Figure 13: Client response on Services Required

Application for official search was the most sought after service followed by valuation requisition for stamp duty assessment. 47% of the respondents were seeking data while 40% were seeking consent for various applications such as change of user, extension of user, extension of leases, subdivision of land and amalgamation of land.

4.2.2 Level of Accessibility

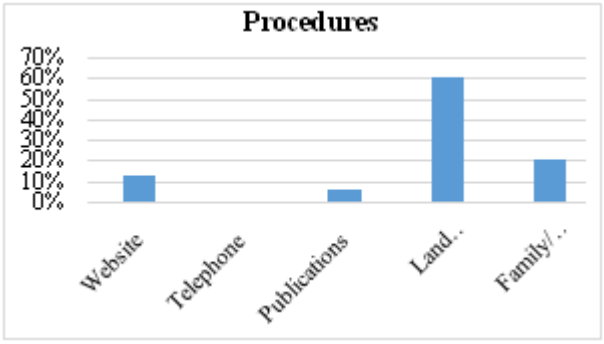

Figure 14: Client response on Services Required

Most of the clients surveyed indicated that they learnt of the necessary procedures and processes through a Land Professional (Surveyor, Planner, Valuer, Conveyancing Lawyer) followed by family and friends and then Ministry website.

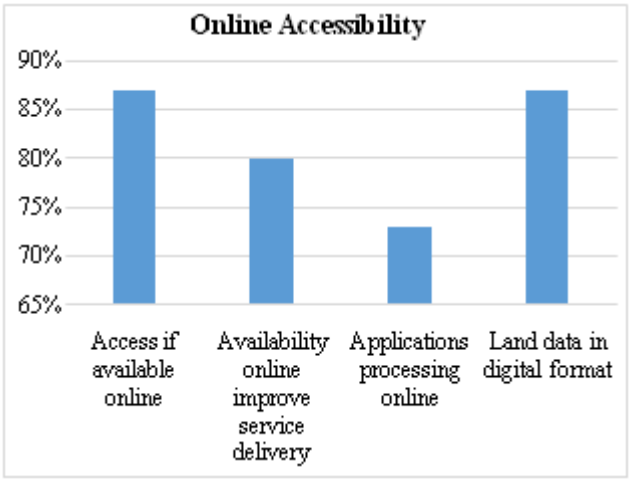

Figure 15: Client response on Online Accessibility

87% of the people sampled indicated they would access the services online if they were available and would obtain data in digital format if availed. It was observed that Digitization process is ongoing in the Ministry but in spite of the existence of digital database, customers cannot get required data and information easily.

4.3 System Application

4.3.1 Database Management

Database of the system that included tables of the land parcels, main roads, schools in the area andother points of interest in the area. The database was connected to the application such that any changes made on any of the tables wouldimmediately reflect on the application.

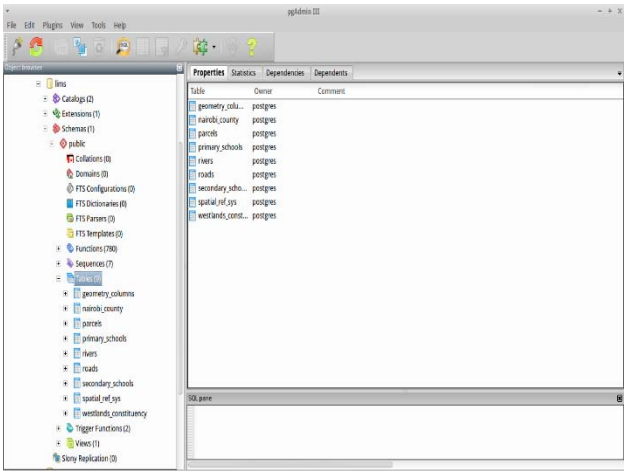

Figure 16: Database in PgAdmin3

4.3.2 Land Information System application

Land Information system application that was to be used to display the spatial map of the area developed and also provide the non-spatial data of the features in the area of interest to the ministry staff and clients. This was done using the Geonode application.

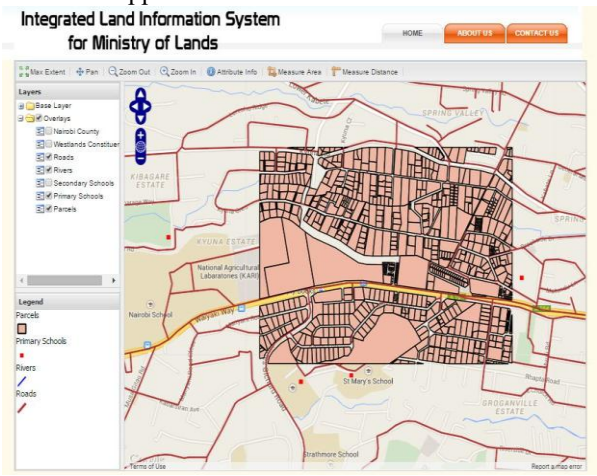

Figure 17: Application Interface

4.4 Functionalities of the System

4.2.1 Viewer Interaction and Display

The system designed has various capabilities which are in build in the system using various tools and include:

- Zoom to full extent ; used to improve the view
- Back and forward : used to locate point of interest on the map
- Zoom in and out ; used to improve the view
- Pan ; to ease navigation on the map
- Identify tool; used to obtain attributes of a feature which is clicked.
- Select ; used to find a feature of interest
- Measure; used to carry out measurements on the map.
- Thematic mapping (display of query results with assigned symbology).
- Distance measurement.
- Area measurement.
- Add point of interest; used to add temporary points on the map by the user whenusing the map.
- Refresh map; used to make the map viewer reload again.
- Reference map for easier navigation.

- Print map and download tool for printing and downloading maps from the system.

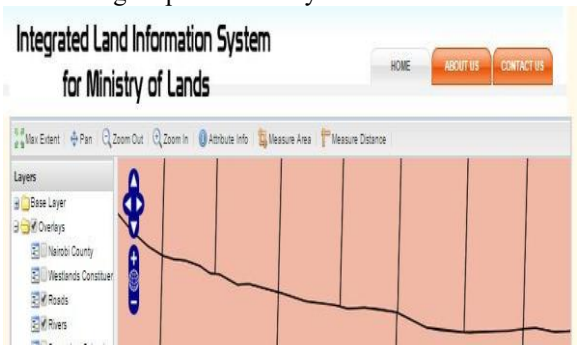

Figure 18: Tools available including zoom, pan, maximum extent and measurements

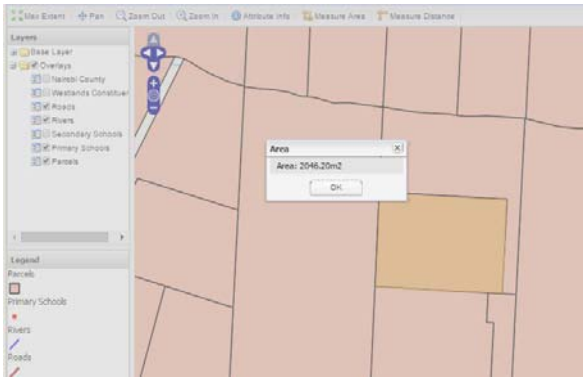

Figure 19: Area measurement tool

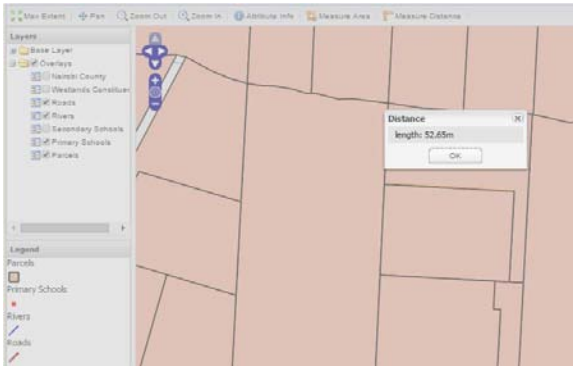

Figure 20: Distance measurement tool

4.2.2 Retrieval of Data

The system provides for the user to be able to search for a specific parcel of land or building using their numbers and hence be able to see the details of them from the database. Illustrated in the figure below.

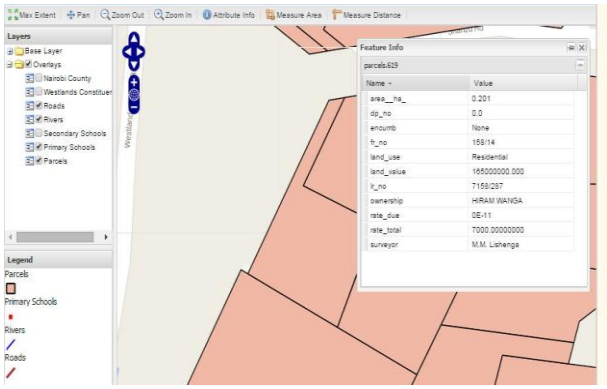

Figure 21: Retrieval of attribute data

4.2.3 Segregation of users

From the user interface page designed there are various access levels to the system depending on the amount of information that can be availed to the user which include:

a) Members of the public;

The general public and any other user of the system can be able to obtain the basic information regarding a parcel of land. Thisincludes parcel number, LR number, acreage, encumbrances, land use, land value,rate total, rates due and Surveyor.

b) For the Ministry staff

Here we have restriction to the people who can access it by providing login by use of user name and password. This is reserved for the for the Ministry staff who deal with land information. They can access detailed information of a given parcel of land which include; owner, tax arrears, value of parcel, encumbrance etc.

4.2.4 Printing and Downloading

This capability is extended to the Ministry staff who are able to print the maps or download the maps from the system. This is made possible by the print map and download tools that are active when one is logged in as the Ministry staff.

4.2.5 Updating

As the system includes a database this means that the information relayed to the users can be kept up to date by having the administrators of the system effecting any changes on the parcel that may take place. For example where we have change of ownership or the type of land use for a given parcel of land.

5. Conclusion

The study was successful as it was able to determine current status of land survey, planning and registration workflow and integrate land survey, planning and registration information within the Ministry of Lands, Housing and Urban Development. It resulted in the development of a web based platform that facilitates user access and data retrieval by developing a prototype for standardized method of capturing, recording and maintaining land related data changes within the various Ministry departments. The system enables the immediate and ready extraction of plot wise detailed information of the land for both the public and the Ministry staff. This system if implemented will also assist the decision makers of the Ministry in making informed decisions on land related information as it will avail the relevant land information required by various departmental sections, professionals and general public.

The Integrated LIS once adopted should provide a common platform for data collection, storage, authorized and secure access to spatial and non-spatial data harmonize the work flow of respective departments and disseminate information for the benefit of public at large. Ministry of Lands, Housing and Urban Development LIS will largely address the needs of various government departments such as Lands, Survey and Physical Planning.

6. Recommendations

The project can be extended to create a nationwide LIS that can provide services for a wide range of customers, starting with government institutions and ending with private individuals.

Further improvements of the system could be made to include more land information and also capabilities improved even to be able to carry out analysis using the available data. Also the systems functionality can be improved such that it supports all of the procedures that are involved in the registration of land.

The system can be further enhanced and integrated into the Ministry website to provide a one stop shop access to land related information. Further integration with a payment gateway such as JamboPay can also be done to enable e-payment for the various services and products offered by the Ministry of Lands, Housing and Urban Development.

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