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Spatial Database System And Visual Interface Creation For Bauchi Refuse Disposal And Sustainable Management Using Geospatial Technology Approach (GTA), Bauchi State, Nigeria

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ABSTRACT*: Among the major spatial challenges of refuse disposal in Bauchi metropolis are; locations of the dump sites, ownership and sustainable management. This research employed the used of geospatial technology approach for the determination of the dump sites using GPS and creation of spatial database system for the study area using ArcGIS 9.3. The study revealed that there are two hundred and ten refuse dumping sites in the Bauchi walled city and among which twenty-five are major (dump site) while the rest are minor (bin) in the database system created. The system was integrated with a virtual interface developed using Virtual Basic 6.0 programming software as an enabling ground for cooperation between stakeholders to aid in its efficient and sustainable management. The study recommends the use of GTA for refuse spatial database system creation and sustainable management.*

KEY WORDS*: Geospatial Technology, Refuse, spatial database system, virtual interface*

I. INTRODUCTION

Disposal of refuse (solid wastes), which are plentiful and jumbled on the earth's surface, has engaged the attention of man since when he began to congregate, urbanize with settling life and to have dominion over the environment. In Nigeria today, the concern for it has continued to grow because the random manners in which refuse is disposed off has not only signal ugly aesthetic scenes, but also introduced high potential risks on health and environment to the country. Consequently, most refuse dumps in the country have now turned to searching centers for raw materials and food with health hazard unchecked. Also, the resultant effects of this scenario at different locations has translated to environmental degradation and the declined in the management of some crucial services such as health, education and transportation that are obvious in the country which are upshots of improper refuse disposal (Daniel and Perinaz, 2012). Disposal of refuse being the only aspect of refuse management activities spatially, it has continued to witness the application of Geospatial Technology (GT) globally aimed at improving the situation. However, refuse disposal and its management are a compelling, difficult task not only in developing countries, e.g., Nigeria but worldwide are still challenging to man (Illeperuma and Samarakoon, 2008; Ayo and Ibrahim, 2011). Therefore, a paradigm shift in approach that not only specifically suitable but also grantees proper planning, effective, efficient and sustainable management of refuse disposal challenges in Bauchi is desirable.

Statement of the Problem : The disposal of refuse at dump sites is still problematic in developing countries. Various techniques are available for refuse disposal management such as; reduce, reuse and recycle, etc. but the final un-use refuse (residue) found in developing cities had to be taken to bin sites and thereafter to incinerators or disposed in landfills. In Bauchi metropolis, spatial information related to bin/dump sites locations and landfills are completely lacking (Shuaibu, 2014). The metropolis is fast growing and more dump sites are coming up with no functional structure as a system to address the problems spatially. Also, the dump sites are haphazardly located and changed unplanned with no database information related to ownership and hence became very difficult to plan and manage the refuse thereby leading to a number of problems (Shuaibu, 2014). According to Patricia and George (2006), one of the most challenging spatial task of the 21st century, is the demand on the creation of spatial database system. Therefore, this research attempted the use of geospatial technology approach for the creation of refuse spatial databae system as a panacea to refuse disposal management problems in the study area.

Aim and Objectives : The research aims at utilization of geospatial technology to create refuse spatial database system to test its effects on the concept refuse disposal and sustainable management for Bauchi metropolis. This was achieved using the following objectives:

[1] To identify and obtain coordinates of all the dump sites in the study area.
[2] To obtain attributes information related to all the dump sites in the study area.
[3] To obtain spatial information on routes and streets name.
[4] To create spatial database system with virtual interface for refuse disposal and sustainable management.
[5] To highlight the benefits of geospatial technology approach in creating spatial database system for refuse disposal and its sustainable management for implementation.

Study Area : Bauchi is geographically located and bounded by latitudes10° 19′ 55″ and 10° 20′ 58″ north of the equator and longitudes 9° 50′ 50″ and 9° 51′ 29″ east of Greenwich (Prime) meridian. The metropolis covers an area of about 3,687 sqkm.

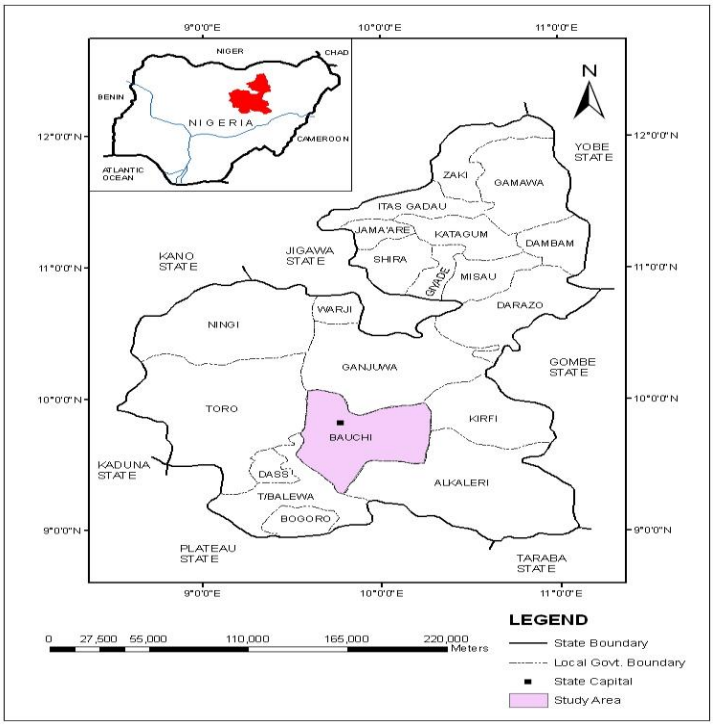


Figure 1. Location map of the study area. Source: (Bauchi State Ministry of Lands, 2013).

The population of the study area, according to the 2006 population census, the result stood at four hundred and ninety-three thousand eight hundred and ten (493,810) persons. Agricultural practices for production of both food and cash crops have captured the life of the inhabitants of the city. The climatic condition of the study area is very hot in the months of April and May while December and January are the coldest months. Mean daily temperature ranges from 28.2°C in August to 36.6°C in April maximum while from about 13.3°C in December to about 22.1°C in April and May minimum (Climate-data.org, 2013).There are two major seasons in Bauchi i.e. rainy and dry seasons. The rainy season months are May to September, when humidity ranges from about 37% to 68%. The onset of the rains has been often in March and they end virtually of October while the dry season starts from November to May (Weather-bug, 2013).

II. METHODOLOGY

In this section, detailed description of equipment used, data acquired, software applied and various methods adopted in this research are given.

Data : The data requirements of this research include both primary and secondary data as follows:

Primary Data:

a. Coordinates of dump sites from Global Positioning System (GPS).
b. Attribute information from the field survey.

Secondary Data:

- Satellite image of Bauchi metropolis.

Equipment and Software

Hardware

The facilities available for this study are:

- HP 620 laptop series, Pentium (R) Dual Core UPU, 700gb HDD, 4GB RAM, 4.40GHz microprocessor speed, Web camp and Keyboard
- Handheld GPS (GARMIN 76)
- HP Desk Jet 2050A 3 in one Printer
- HP Photo Smart (C5500 Series) printer, scanner and photocopier
- External Drive 500GB

Software

The software includes the following:

- ArcGIS 9.3 Software by ESRI
- AutoCad 2002
- Virtual Basic 6.0 Programming Language by Microsoft
- Google Earth Pro 4.2
- Microsoft word

Refuse Spatial Database System : The creation of the spatial database system was achieved in this section as underneath:

Importation of image into ArcGIS : The image of the study area captured from Google Earth was stored and imported into ArcGIS from the folder SPATIAL DBASE. While importing the image via Arc Catalog; pyramids, spatial reference and statistics were created, added and calculated respectively for rapid display at different resolution. The work was saved in the same folder on the Hard Drive C on the computer used for the research.

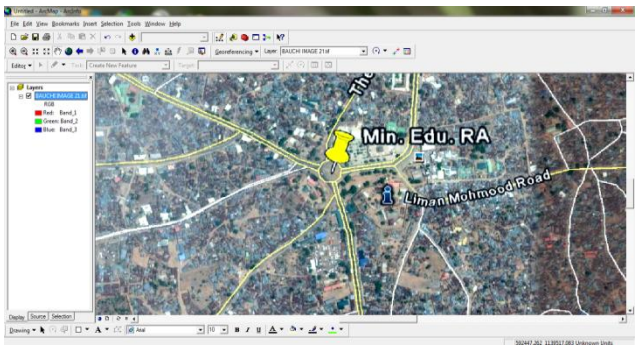


Figure 2. Imported image of the study area.

Georeference of the image : The image of the study area was imported into Arc Map environment and georeferenced. The UTM coordinates of prominent points in the vicinity of the study area obtained during the field work were used for the georeference. Hence the image has attained the geodetic references required.

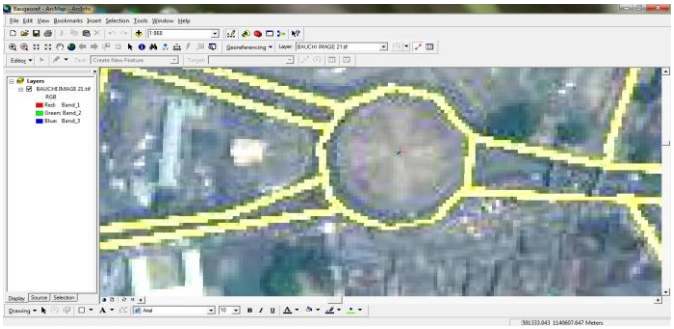


Figure 3. Georeferenced image of the study area.

Creation of Shape Files : Dump sites and routes are the basic themes required in this section and consequently, they were created in the Arc Map environment by importation and digitization work. The digitization was achieved via on-screen method. The road network in the study area was digitized and edited as an independent thematic layer as in the fig. 4. The coordinates of dump sites obtained in the area were typed in excel and imported into the Arc Map window through; tools, add x y data from the folder in which the points were saved. Also, projection parameters such as; UTM, WGS 84, Zone 32 were edited, selected and applied and hence the layer created. Moreover, and in order to make selection, querying and further editing in the table to be possible, the layer was exported by right-click in table of content, export data and added to the map as new layer was selected while the initial one was deleted as also seen in the fig. 4.

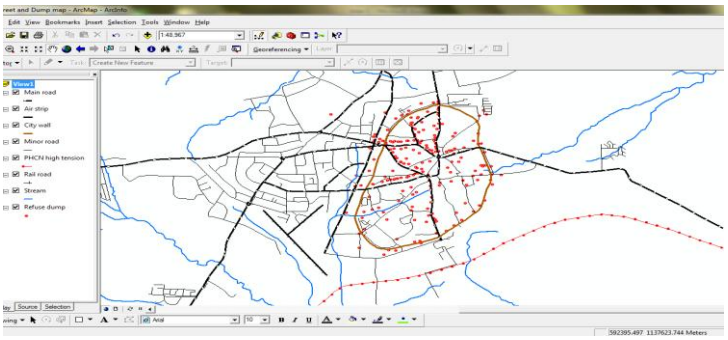


Figure 4. Digitized route network and stream of the study area.

Creation of tables and relational database : The table automatically formed after the importation of dump shape file into the Arc Map environment, was then used in the relational database creation. The existing fields (columns) in the table were edited and new ones formed. While creating new fields on the table, some rules were observed and they include; field name, and field properties. Hence, columns like dump ID, dump No., surv. No., land No., street name, and area, value of improvement, land use, land tenure, rent, term and status were all created. The records (rows) are created and added to the table as soon as a dump is imported. Based on the attribute information obtained from the survey, the records were further populated by typing in the information. Other tables such as; owner, building/haul, register and ward tables were created in Microsoft Office Excel software and later imported into the ArcGIS environment then linked together in the dump table. The linking was achieved by joining the five tables together through a common identifier (Dump ID) to form one table and hence, the relational database.

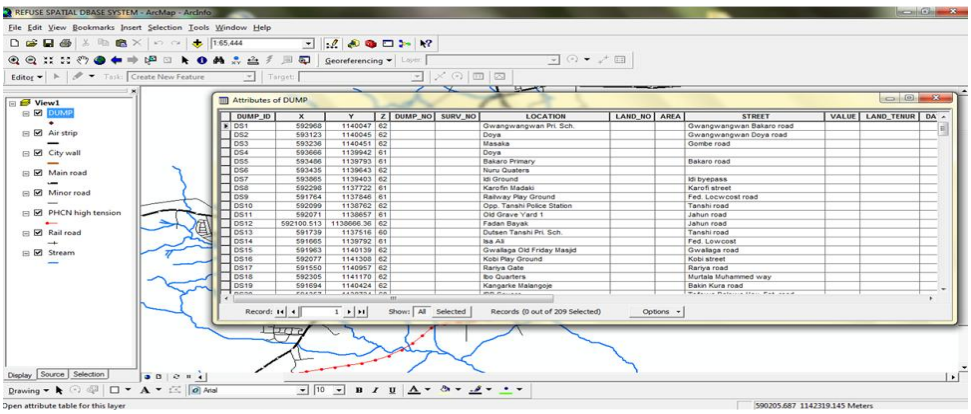


Figure 5. The relational table of the database.

Creation and connection of virtual interface form with database : In this section, virtual basic software was used to write a program that enables users of the relational database created in the above to interact with the system. This was achieved by creating a user interface form. The formed was created using create new project and the default form was accepted. Seven command buttons are then created, added and placed at the lower portion of the form. The first among them was the Adodc1while others include; search, edit, save, insert, delete and close (see Fig. 6).

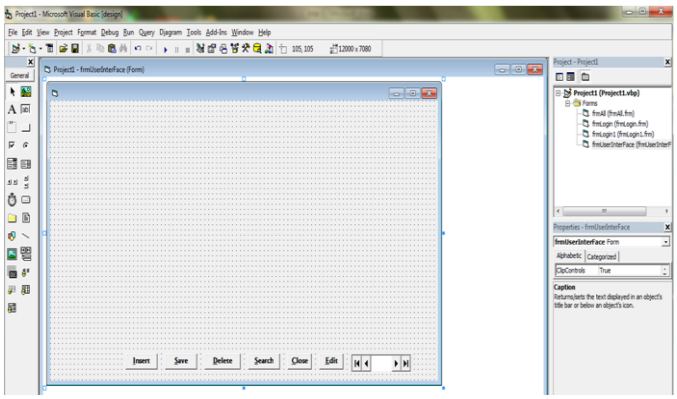


Figure 6. The Adodc and Command Buttons of the User Interface.

Six other command buttons were added onto the user interface form and linked to the Adodc1 that was linked to the spatial database for them to retrieved information. There are twenty-three fields in the spatial database that was early created. These fields are; 'dump ID, dump No., surv. No., land No., location, street name, area, date of allocation, value of improvement, land use, land tenure, rent, term, status, dump site image, owner name, address, occupation, sex, date of birth, place of birth, state of origin and nationality' and were added onto the virtual interface form in the visual basic environment using Labels and Textboxes. The Labels carried the fields' names while the Textboxes provided spaces for each label's attribute respectively. The command buttons, Labels and Textboxes are created by clicking their icons, dragged and placed at different but appropriate locations for the fields on the interface form.

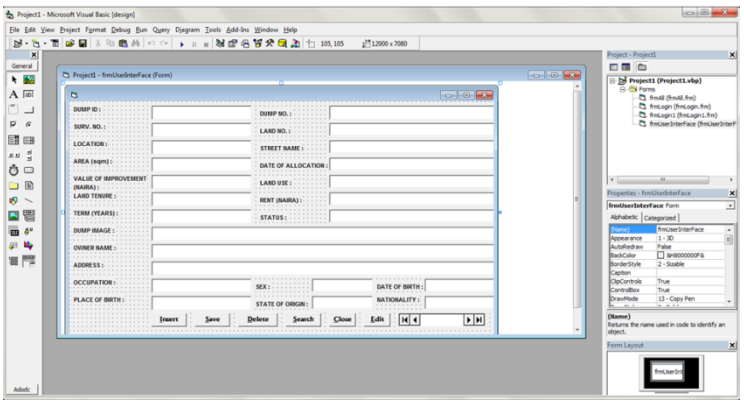
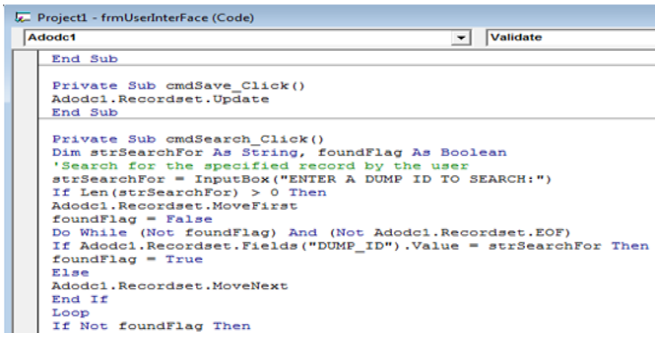


Figure 7. The Command Buttons, Labels and Textboxes of the User Interface.

Addition of Visual Basic Codes to the Command Buttons

The program's that enabled the functioning of all the command buttons and Adodc1 were then added, see Fig. 8.



```
Project1 - frmUserInterFace (Code)
Adodc1                                   Validate
    End Sub

    Private Sub cmdSave_Click()
    Adodc1.Recordset.Update
    End Sub

    Private Sub cmdSearch_Click()
    Dim strSearchFor As String, foundFlag As Boolean
    'Search for the specified record by the user
    strSearchFor = InputBox("ENTER A DUMP ID TO SEARCH:")
    If Len(strSearchFor) > 0 Then
    Adodc1.Recordset.MoveFirst
    foundFlag = False
    Do While (Not foundFlag) And (Not Adodc1.Recordset.EOF)
    If Adodc1.Recordset.Fields("DUMP_ID").Value = strSearchFor Then
    foundFlag = True
    Else
    Adodc1.Recordset.MoveNext
    End If
    Loop
    If Not foundFlag Then
```

Figure 8. Visual Basic Code Editor for command buttons.

Creation of Login Form for the Virtual Interface : In order to provide security to the database, a login form was created such that the visual interface can only be opened when correct user name and password are provided and appropriately entered (see Fig. 9).

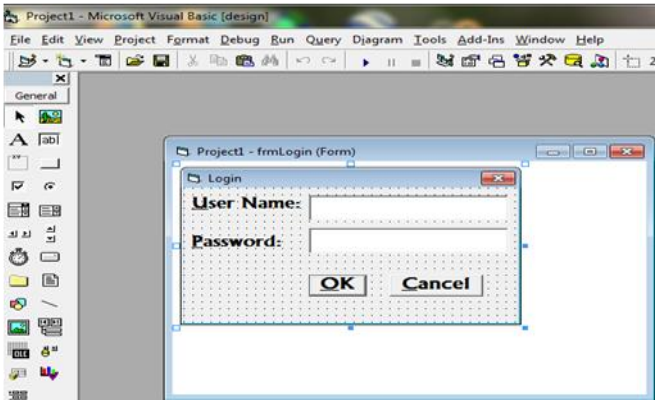


Figure 9. The Login Form of the Visual Interface.

Addition of Visual Basic Codes to the Login Form

The codes that control the program's functions were added to the user form as shown in fig. 10 below:

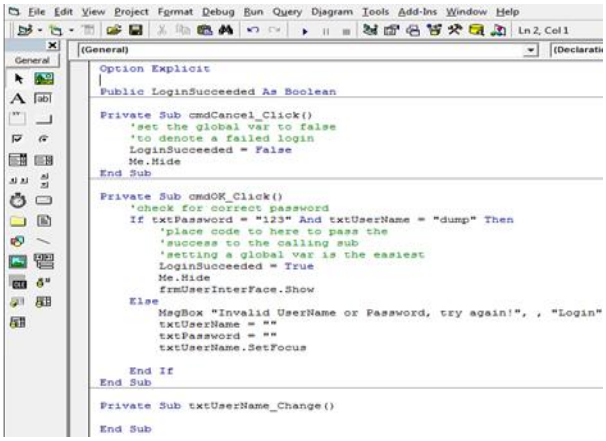


Figure 10. Visual Basic Code Editor for adding program to the Login Form.

Creation of Editing Table for User Interface : The user interface table, which is a table that allows the user to edit existing records, was created as shown in Fig.11.

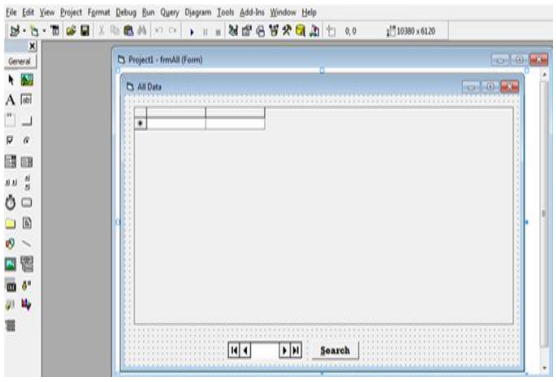


Figure 11. The editing table of the User Interface.

Addition of Visual Basic Codes to the editing Table : The codes that will control the program's functions were added to the user form as seen seen in Fig. 12.

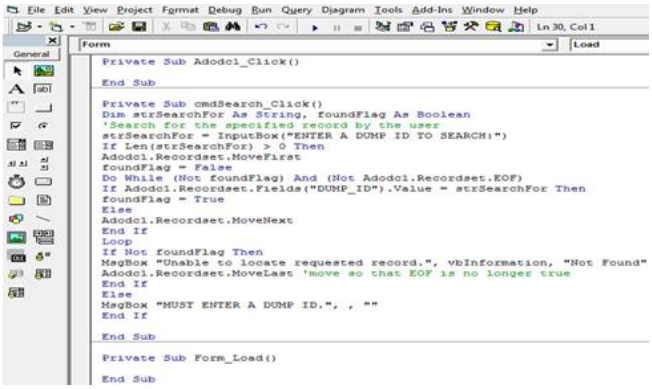


Figure 12. Visual Basic Code Editor for adding program to the editing table

Creation of Login Form for editing table : In order to restrict the editing work, a login form was created such that the editing table can be accessed only, when correct password is provided in textbox (see Fig. 13). This was achieved through the following steps:

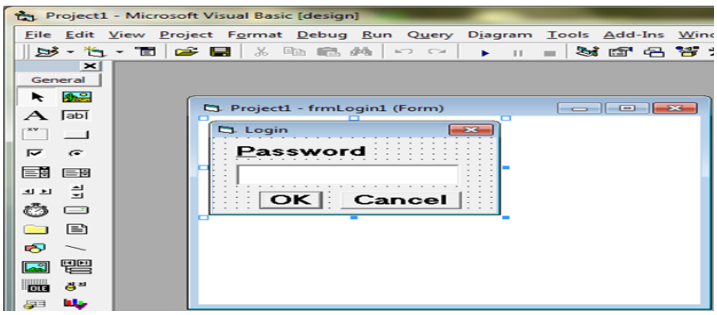


Figure 13. The password Login Form for editing table.

Addition of Visual Basic Codes to the password Form for Editing : The codes that will control the program's functions were added to the user form through the following steps (see Fig. 14).

Figure 14. Visual Basic Codes added to the password Form for Editing.

III. RESULTS AND DISCUSSION

The refuse spatial database system of the study area : Refuse spatial database system refers to the spatial and attribute data bank as an organized system of refuse information for proper planning and sustainable management. The information is structured in a way that rooms are provided for both expert and technologist to carry out various functions in all the permitted areas without hindrance. This was achieved through the creation of four forms with five different functionalities as discussed in these subsections.

The virtual interface desktop login form : After the creation of the virtual interface in the virtual basic environment, desktop shortcut login to lunch, view and work on the interface form was created. To log in, two information are required; user name and a password. If the correct information are entered, accessibility to the interface form is quickly enabled when ok is clicked otherwise a warning is alarmed. Fig.15 shows the desktop login icon for access in to the virtual interface form.

Figure 15. Desktop login icon in to the virtual interface form.

The virtual interface database management form : The virtual interface form contents all the relevant headings about the information content of the spatial database. All the relevant information on the database can be searched, viewed and edited from the interface form. However, for any editing work, correct password has to be entered before it can be carried out. Fig. 16 shows the virtual interface form accessed from the desktop.

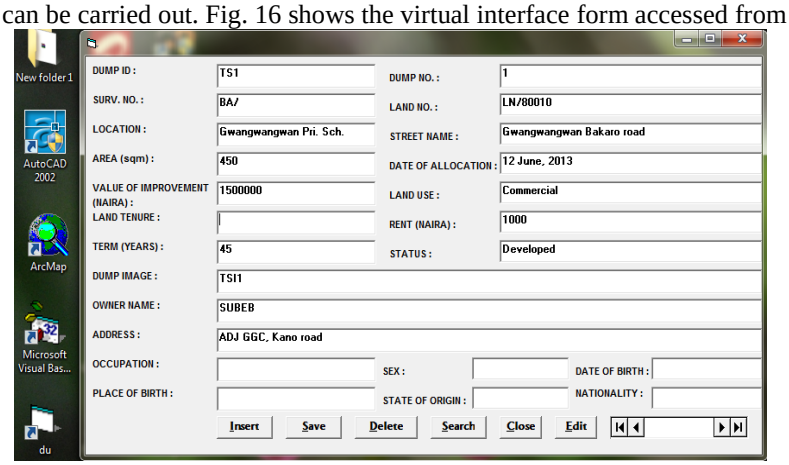


Figure 16. The virtual interface form

The database editing and control login form : Information from the database can be edited from the virtual interface. This is achieved by clicking the edit button and providing the correct password. The password served as integrity checks so that the data is altered only when it is intended. On this platform, data can be added or deleted and finally saved. Fig. 17 shows the password editing box for imputation of correct password.

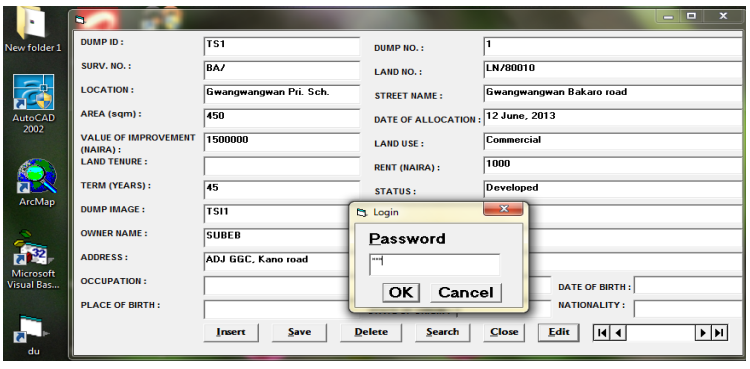


Figure 17. Edit database password login form

The database information table form : The table created in the virtual interface form is to hold row information for editing. On this form, individual item can be searched by entering its correct ID otherwise search fails. Fig. 18 shows how the table looks like with all the available information that can be scroll left and right and search up or down.

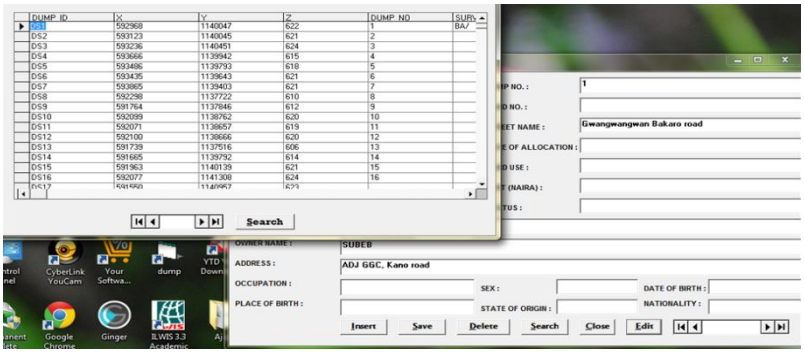


Figure 18. Desktop database editing table.

The quick search item in the database information table form : The button on the table for item search provides a box to key in the property ID and interactively viewed the results. Once the ID is correct, the searching process will roll up or down to find the item and display (see Fig. 19).

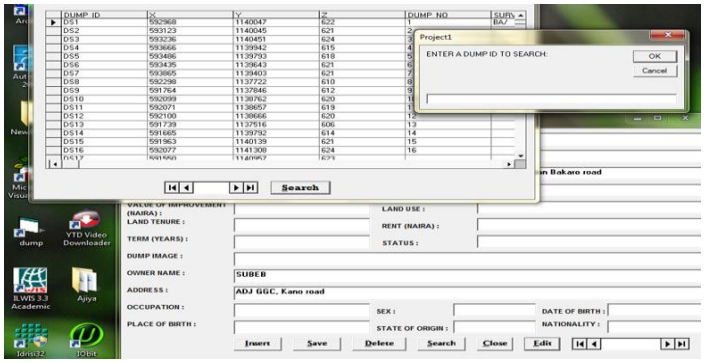


Figure 19. Item search on the table login form.

IV. CONCLUSION AND RECOMMENDATION

There are two hundred and ten refuse dumping sites in Bauchi walled city and its close vicinity. Among which twenty-five are major (dump) while the rest are minor (bin). The creation of the dump sites database was achieved using geospatial technology for the study area. This work will help in the effective management of database and ensure sustainability of the system. It is hereby recommended that, the dump/haul/bin within the study area should be hot linked to the spatial database system to make a multimedia. This can be achieved using Google earth with internet facility to capture locational image of all the dump sites. Each image will then be joined to its individual dump site by creating another field (DUM_IMGE) on the table having links to the location of the images as attributes such as 'C:\SPATIAL DBASE\REFUSE IMAGE\DTS1 Gwangwan-Bakaro Road.JPG'. Also, developing cities maximize the utilization of geospatial technology approach to address the problem of refuse management in their areas. Also, the Bauchi State Environmental Protection Agency (BASEPA) should in conjuction with Ministry of Lands and Survey acquire the dump sites based on overriding public interest.

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