wjert, 2020, Vol. 6, Issue 3, 440-455. Case Study ISSN 2454-695X

World Journal of Engineering Research and Technology

WJERT

www.wjert.org

SJIF Impact Factor: 5.924

CADASTRAL INFORMATION SYSTEM (CIS) – A VIABLE METHOD FOR HARNESSING THE ECONOMIC INTEREST INHERENT IN LAND: A CASE STUDY OF FEDERAL LOW COST HOUSING ESTATE, OYO, OYO STATE, NIGERIA

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Article Received on 24/03/2020 **Article Revised on 14/04/2020** **Article Accepted on 04/05/2020**

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ABSTRACT

Our country is currently passing through one of the most perilous period of her existence as an independent nation economically. This chronic economic recession was down to the fall in the price of crude oil in the international market which is not unconnected to the global campaign promoting development of eco-friendlier energy sources. The current state of the nation's economy is a pointed testifier to the need for government at all level to look inward and seek to diversify the economy to source funds even in times of combating the pandemic COVID 19. Land exists in no small quantity in Nigeria but while the Nigerian constitution granted the government control over the utilization of land, it seems the excess revenue from crude oil in the years past have blinded government at all levels to other viable sources of Internally Generated Revenue (IGR). Now the onus is now on all arms of government to drastically work toward salvaging the current economic situation before it turned crisis. Cadastre is a daily maintained record of interest in land. Because of the enormity of data involved in the maintenance of a Cadastre, Information Technology (IT) is now being applied. Cadastral Information System (CIS) helps to eradicate the irregularities found in most analog cadastral system and equally makes for efficient utilization of cadastral information. This paper demonstrates on a small scale how the aforesaid can be achieved. It also discusses some

measures to be taken to ensure such effort achieve its general intendment. Conclusively, it implores government at all levels to develop a cadastral information system.

KEYWORDS: Land, Cadastre, Cadastral Information System (CIS), Internally Generated Revenue (IGR), Economy.

1. INTRODUCTION

Nigeria, widely addressed as the giant of the African continent, and rightfully so considering its enormous population in comparison to other nations in the African region, has so far for too long remained in the deplorable state of economic recession. Form recent indices the country's population stands at one hundred and ninety-five million, eight hundred and seventy-five thousand, two hundred and thirty-seven (195,875,237) which is a huge responsibility to cater for a developing nation. Interestingly, the nation is equally hugely blessed with a number of solid and liquefied minerals as well as a wide expanse of agrarian land spanning a varied number of ecological regions. Weighing in on all this perhaps positive indices, it comes out as disturbing that the nation for years continues to wallow in the lugubrious waters of economic downturn.

1.1 Economic Recession

What is economic recession? Economic recession is a period of general economic decline and is typically accompanied by a drop in the stock market, an increase in unemployment, and a decline in the housing market. Generally, a recession is less severe than a depression. The blame for a recession generally falls on the federal leadership, often either the president himself, the head of the Federal Reserve, or the entire administration.

This current economic recession (owing to lesson from great depression, 1981, 1991, 2004, 2008-2009 global economic recessions) can be attributed to various factors which may include but is not limited to poor economic planning, high inflation rate – a general rise in price of goods and services – leading to low purchasing power, high-interest rate – discouraging investor, high taxation, policy conflict, accumulation of debt servicing especially foreign debts, fall in aggregate demand, fall in wages, income; mass unemployment and general loss of confidence on the government due to economic indices.

Giving credence to the above assertions, "Noko (2016)" as cited in Sunday (2017) opined that while considering the Nigeria Economic indicators, it suggest possible economic policy

measure to end economic recession in Nigeria to include reduction in tax rate, effective spending, enhanced access to credit, Nigeria government should increase her expenditure on skills, increased manufacturing produce and export, invest in the energy sector to reduce power outage, engage the Niger-Delta militants in a dialogue, reduce the tax rate or regulate same to avoid double taxation, borrowing from both domestic and foreign should be invested more on infrastructure, funds should be sourced more from the domestic economy than the foreign investor to avoid the incidence of capital flight, the government should work with the legislative body to endure speed execution of her project, commodity price and raw material price should be regulated through consumer protection agency to avoid further inflation.

From the foregoing it can deciphered the need for government at all levels to garner all available resources into a pool of fund needed to resuscitate the economy and lift it out of the current recession. If that was to be achieved, then the federal government in her role as the chief administrator of the economy should seek to engage all sectors to jointly pursue the unified goal of harnessing the economic value of all available resources. Land has an unprecedented role to play in this direction.

1.2 Economic Importance of Land

Land exists in Nigeria in enormous quantity. Nigeria's land mass has a coverage of approximately nine hundred and twenty-three thousand, seven hundred and sixty-three square kilometers (923,763 km^2). This wide land coverage is almost evenly distributed among a wide spectrum of five different ecological zones ranging from the wet mangrove rain forest down south to the arid Sahel savanna up north. This variation in ecology had been efficiently utilized in the years past. However, the advent of exploration of crude in the southern coast nudged the national government into deep slumber in the area of harnessing the economic value inherent in land.

One basic advantage of land as economist Matt Rognlie has found, the return to land is responsible for the lion's share of the increase in wealth inequality documented by French economist Thomas Piketty. So in order to address wealth inequality, it's important to focus on land. Even after the rise of the modern corporate economy, unequal ownership of the most basic and ancient asset of them all is still creating big divisions in our society. Furthermore, despite the explosive growth of corporations since the Industrial Revolution, land still represents a huge percent of all the wealth in the economy. What's more, focusing only on capital gains neglects the extremely important fact that land earns income from rent. Land

though fixed in nature can skyrocketed in value over a short period if favorable conditions persist.

The current regulations guiding land administration in Nigeria endowed government administrators' optimal control over lands in all states of the federation. Specifically, aside lands within the grasp of individual land owners, a wide portion of the state lands is held in trust by their respective administrators. Most of these lands were adequately survey in the past years, however their geometric and attribute information exist only in analogue form which makes updates and reviews a herculean task if not impossible.

Of paramount importance to ensuring proper utilization of any resources, is the availability of adequate information, describing its nature as well as other relevant detail. Land as an abundant natural resource intrinsically requires proper information management to adequately harness its full potential. However, unavailability of viable information about features of interest has always been the bane of most of the developmental efforts in Nigeria. Though all states of the federation have their respective data bank of land record but such records in larger cases exists only in analogue form and where they are available in digital form there is no systematic approach to ensuring they are up to date. Ultimately, the country has no unified system of keeping land record and management of same.

1.3 The Cadastre

A cadastre is generally a parcel based, and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It is a comprehensive land recording of the real estate or real property's metes-and-bounds of a country. Its areas of application are widely categorized into basically Fiscal, Juridical and Technical cadastre. The fiscal aspect has to do with the government utilizing it for taxation and other land administration. The juridical reminds of the fact that cadastral maps are essential instruments in legal documentations of lands in dispute. The technicality however has to do with the procedural techniques of developing a system of graphic representation of land of a state or region. Cadastral conventionally includes two categories of information, a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements.

Graphical indices of these parcels, known as cadastral maps, present the relative location of all parcels in a given region. Cadastral maps commonly range from scales of 1:500 to

1:10,000. They are large scale diagrams, plans or maps showing more precise parcel dimensions and features (e.g. buildings, irrigation units, etc.) and are often the product of cadastral surveys for each parcel mostly based on ground surveys and aerial photography. Information in the textual or attribute files of the cadastre, such as land value, ownership, or use, can be accessed by these unique parcel codes shown on the cadastral map, thus creating a complete cadastre (Henssen, 1990).

The principal responsibility of the assessor is to locate inventory, and appraise all property within the jurisdiction. A complete set of maps is necessary to perform this function. Maps help determine the location of property, indicate the size and shape of each parcel, and reveal geographic relationships that affect property value. Maps and map data are important not only for assessors, but also for other governmental agencies, the public, and the land information community (such as realtors, title companies, and surveyors). In addition, the assessor must track current ownership of all parcels, so that the proper party can receive assessment notices and tax bills (Ibraheem, 2012).

1.4 Computerization of the Cadastral Mapping Systems

Computerization of map and parcel data can enhance the capability to manage, analyze, summarize, display, and disseminate geographically referenced information (Larsson, 1991). Working with digital cadastral maps and tabular parcel related data in a GIS, users can selectively retrieve and manipulate layers of parcel and spatial information to produce composite maps with only the data they need. Sharing GIS files over an internal or external data network makes parcel maps and related attribute information widely available, and reduces the duplication of effort inherent in separate map systems. Such sharing is becoming increasingly sophisticated, ranging from allowing users to download data or prepared maps, allowing users to make sophisticated queries that may draw on the power of the host GIS's software and hardware (Wan & Williamson, 1995). Computerized mapping systems may be referred to by several names. They include (ASCE, 1998):

i. Geographic information system (GIS).
ii. Land information system (LIS).
iii. Digital multipurpose cadastre.
iv. Multi-Purpose Land Information System (MPLIS).
v. Land parcel database.

1.5 GIS and the Digital Cadastre

A GIS is most often associated with a map. A map, however, is only one way that can work with geographic data in a GIS, and only one type of product generated by a GIS. A GIS can provide a great deal more problem- solving capabilities than using a simple mapping program or adding data to an online mapping tool (creating a "mash-up"). A GIS can be viewed in three ways (Ibraheem, 2008):

a. The Database View.
b. The Map View.
c. The Model View.

Together, these three views are critical parts of an intelligent GIS and are used at varying levels in all GIS applications. Data needed for GIS can be obtained in various ways and are stored in a digital form, they are known as digital data in GIS today. Digital data are obtained primarily by the following means (Ibraheem, 2008):

i. Incorporating remotely sensed data into GIS.
ii. Digitizing existing maps and plans.
iii. Digitizing Ariel photographs (mono or stereo).

1.6 Components of a Digital Cadastral Mapping System

A digital cadastral mapping system should have the following components (Wan & Williamson, 1995):

i. Reference to a geodetic control network.
ii. Current base map layer (ideally, photogrammetrically derived).
iii. A cadastral layer delineating all real property parcels.
iv. Vertical aerial photographs and/or images (ideally, ortho-rectified).
v. A unique parcel identifier assigned to each parcel.
vi. A means to tie spatial data to attribute data (ownership and parcel characteristic files).
vii. Additional layers of interest to the assessor, such as municipal boundaries, zoning, soil types, and flood plains.

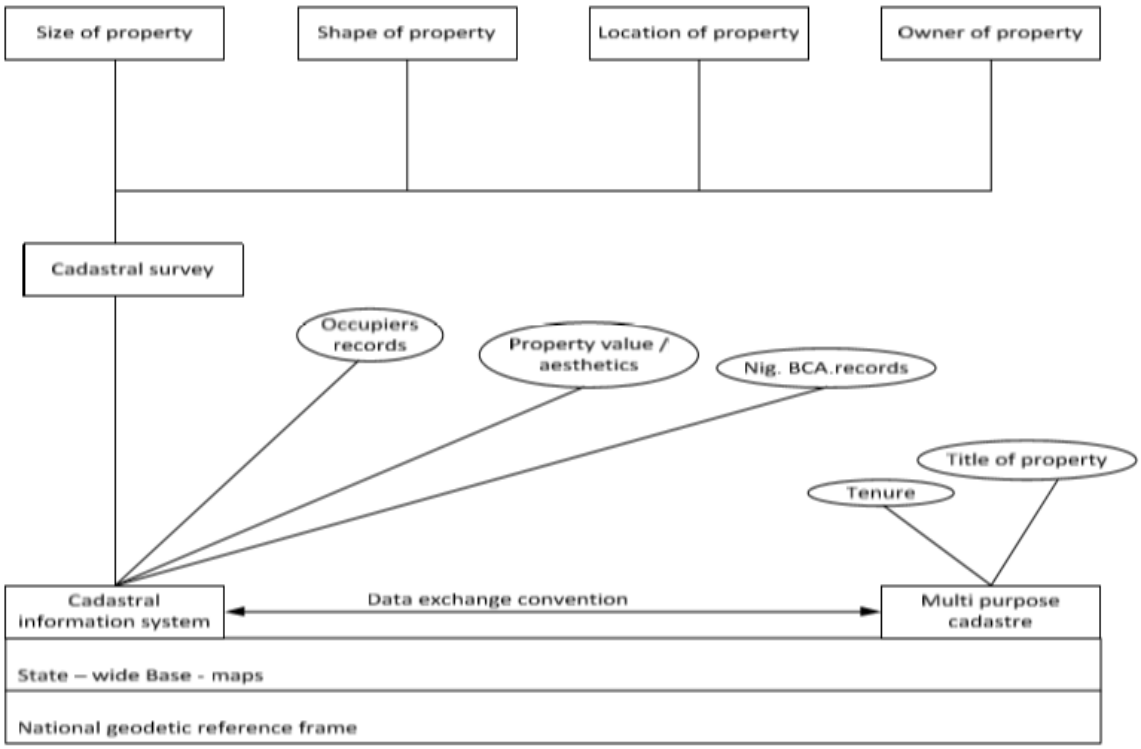

Figure 1: Schematic diagram showing the interconnectivity between a cadastral information system and a digital multipurpose cadastre (Kemiki, Odumosu, Ayoola & Popoola, 2015).

1.7 Benefits of a Digital Cadastral Mapping System

The justification for computerizing cadastral maps includes the following:

i. The reduction of duplication in maintaining a cadastral base for many users.
ii. As a result of converting maps from one scale to another.
iii. To bring the cadastral map onto the same coordinate and mapping system as large scale topographic maps, thereby facilitating LIS/GIS applications.

An important issue in establishing a Digital Cadastral Data Bases (DCDB) is that computerization of the cadastral maps in general cannot be justified for land registration or land market reasons. Therefore, computerization of the map requires the support of other users both financially and institutionally. At the institutional level, there is an issue of who is responsible for maintaining the DCDB and distributing the updates. Obviously it is necessary for one organization to administer the DCDB although there are various models using both government and the private sector to maintain the system (Williamson and Enemark, 1994, Enemark, 2009).

1.8 Current Trends in Digital Cadastral Mapping System

Large-scale geographic and land information systems (GIS and LIS) are developing rapidly in local and state governments and other organizations across countries in the world. These systems handle critical information related to land parcels, transportation, utilities, and other infrastructure and facilities. They are changing the way organizations operate and make decisions, and therefore, they affect the daily activities and lives of the citizens and customers of these organizations. The attributes of different types of geospatial data— such as land ownership, roads and bridges, buildings, lakes and rivers, counties, or congressional districts—can each constitute a layer or theme in GIS. (See Figure 1 for a schematic representation of data layers in GIS.)

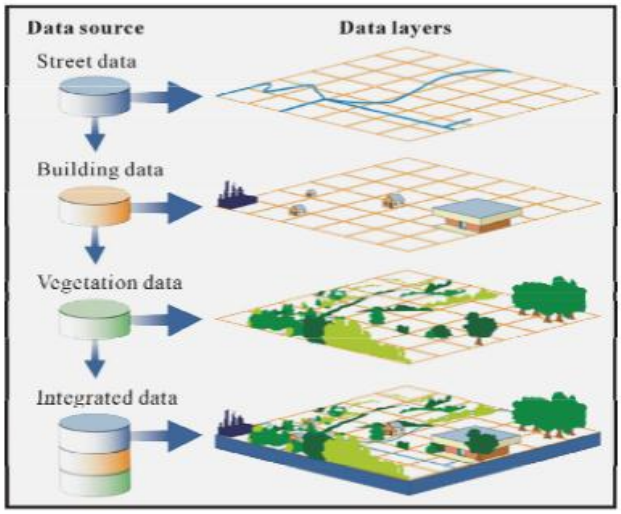

Figure 2: Example of GIS data layers or themes (Folger, 2009).

This paper presents a GIS based approach for the creation of a Cadastral Information System for the Federal Low Cost Housing Estate, Ori-Awo, Oyo East Local Government Area, Oyo, Oyo State.

2.0 CASE STUDY

Federal Low Cost Housing Estate is located along the Old Oyo / Ogbomosho road in Oyo Town in Oyo State, with a land area of approximately 58.5 Hectares. Built by the Federal Government to ease accommodation pressure amongst middle income earners especially civil servants within the state, the sale of the estate enjoyed adequate patronage. Considering however the extent of the estate, appropriate and up-to-date geospatial-database of all residents and their occupation is essential to mitigate possibilities of in-security within the

estate and to allow government adequate management and efficient revenue generation within the state.

Figure 3: Satellite imagery of the study area (Google Earth, 2018).

3.0 METHODOLOGY

The design of the Cadastral Information System was done in stages as listed below:

a. Conceptual Design
b. Logical design
c. Physical Design
d. Relational database

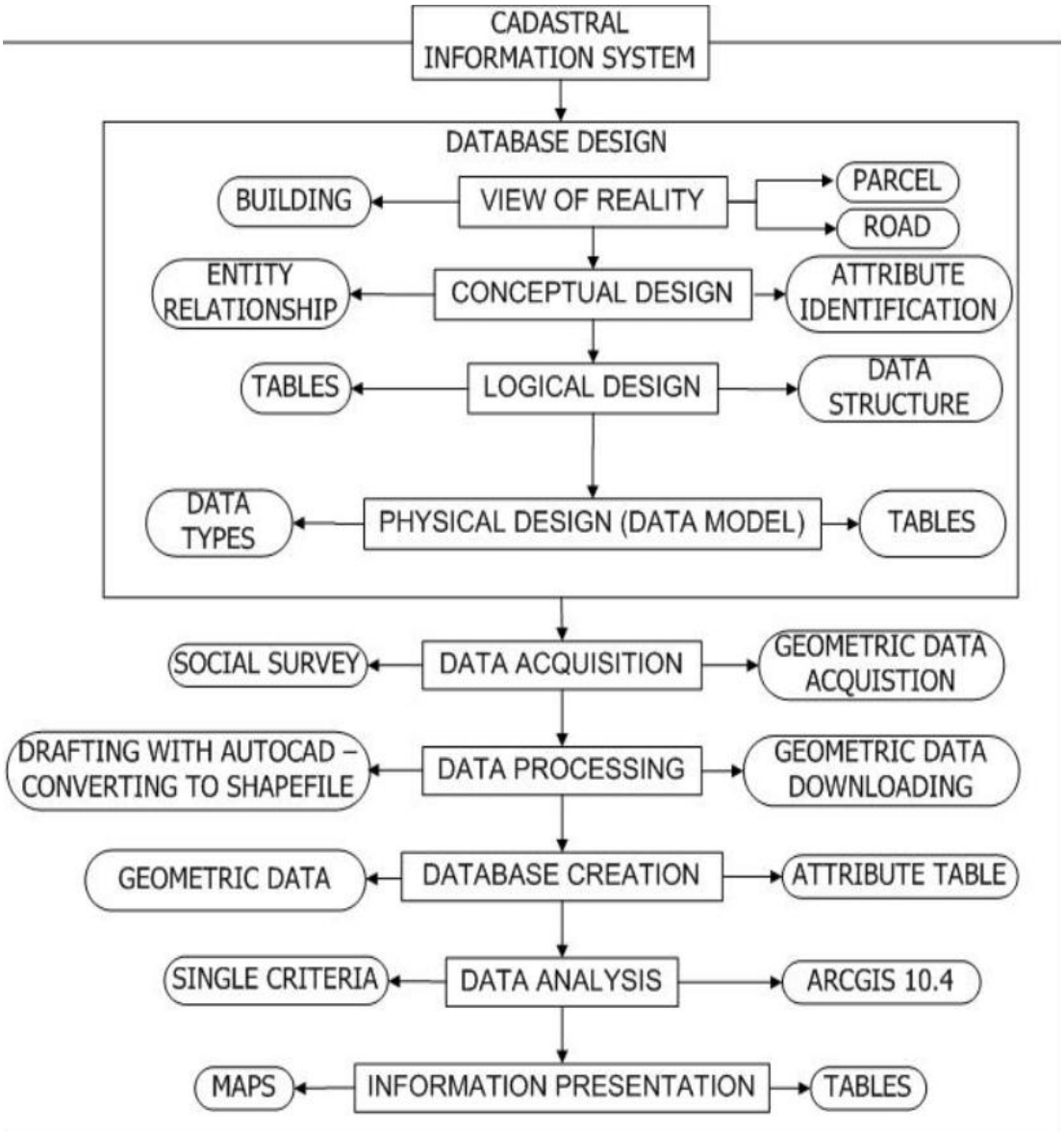

Figure 3: Framework of the Research Methodology (Field Record).

3.1 Conceptual design

The conceptual design phase succinctly describes the operations geared toward creation of a mental abstraction of the real world. The real world (also Reality) involves many complexities that creating a model of it is greatly difficult. Thus there is the need to develop a view of reality which is a mental abstraction of the real world entities that bears direct relevance to the application at hand. At this stage, real world entities relevant to the application were identified and they are conceptualized as point, line or area features.

3.2 Logical Design

Logical Design encapsulates both the logical design and data abstraction phases. The process of logical design involves arranging data into a series of logical relationships called entities

and attributes. An entity idealizes a piece of information while attributes are components of the entity that define the uniqueness of the entity. In relational databases, an entity is depicted in tabular form with each entity recorded as a field and the attributes along the tuple. During Logical Design, an ER diagram is drawn to depict the workflow. Drawing an entity-relationship diagram aids understanding of the organization's data needs and can serve as a schema diagram for the required system's database. All required attributes of the entity were thus identified and linked appropriately in the ER diagram to facilitate easy building of the database.

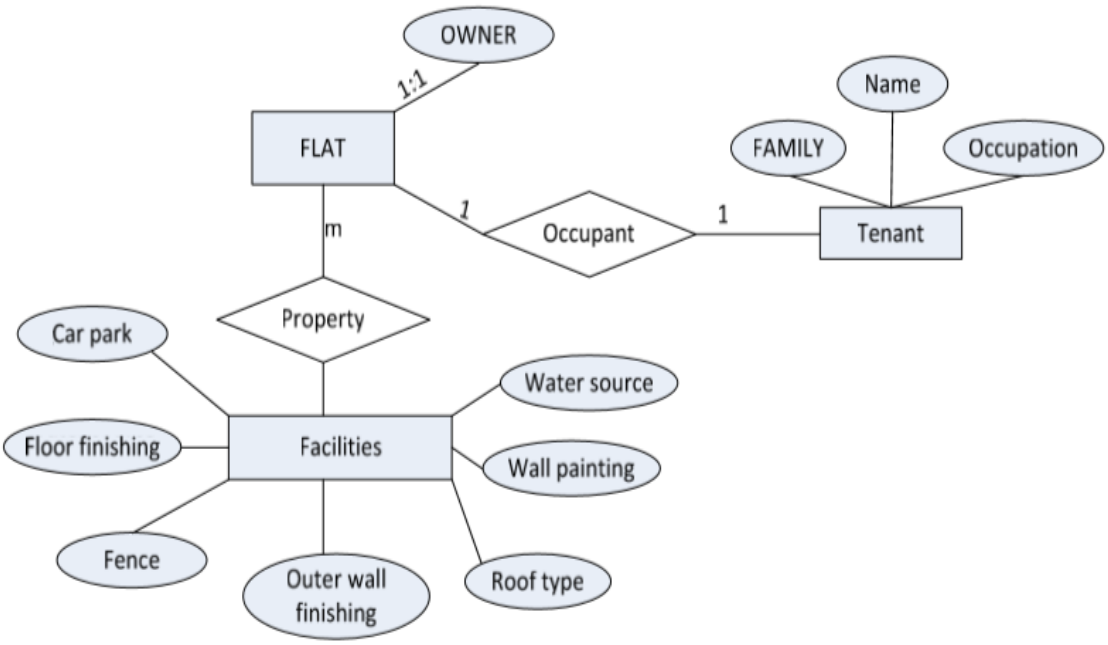

Figure 4: An E-R Diagram for the Conceptual Design (Field Record).

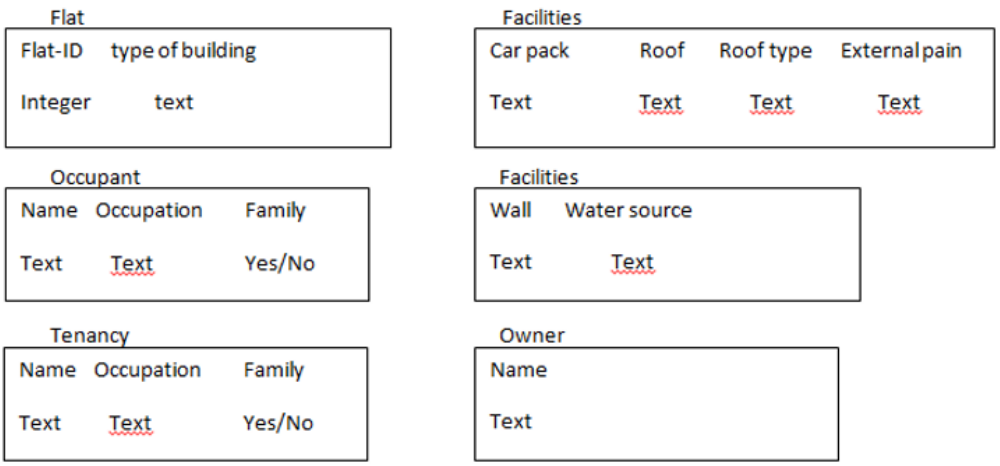

Figure 5: Mapping the E-R model to the Relational Database (Field Record).

3.3 Physical Design

This is aimed at creating physical relational database tables to implement the database design (Haithcoat, 1999). The required hardware, software, file structures and system memory requirements for execution are put into consideration and implemented as appropriate. In building a Cadastral Information System, the process involves the procedure of building every other data base system i.e. software, hardware, data, procedures, database access language etc. To facilitate the database creation, real-time GPS was used to pick the co-ordinates of the bounding points of the entire area. With a base station established at XSN 07, the rover was moved round the boundary points of the study area to determine precisely their co-ordinates to an acceptable accuracy level. Thereafter, a Google earth imagery covering the study area was acquired and geo-referenced with the boundary co-ordinates earlier determined using Simple Helmert Transformation. The fully geo-referenced image was then vectorized as appropriate in parcel based (flat by flat) to create the full spatial database of the study area. Questionnaires were then distributed to all residents to fill in their personal information as regards their full names, occupation, number of children, source of water etc. Also, other non-spatial information as regards the status, type of buildings etc. were observed and recorded accordingly.

3.4 Relational Database

A relational database is such which is perceived by the user as a collection of two-dimensional tables. They are manipulated a set at a time, rather than a record at a time and in advanced cases the SQL is used for its manipulation (Haithcoat, 1999). The ArcGIS software was used to build the spatial and aspatial database for the study area. With the spatial data represented in their appropriate geometric forms, the relational database table was used to link the spatial data with the attributes for each parcel.

4.0 RESULTS

A parcel based Cadastral Information System for the study area was created comprising all parcels in their appropriate geometric representation viz-a-viz the entire land extent as shown in Figure 7.

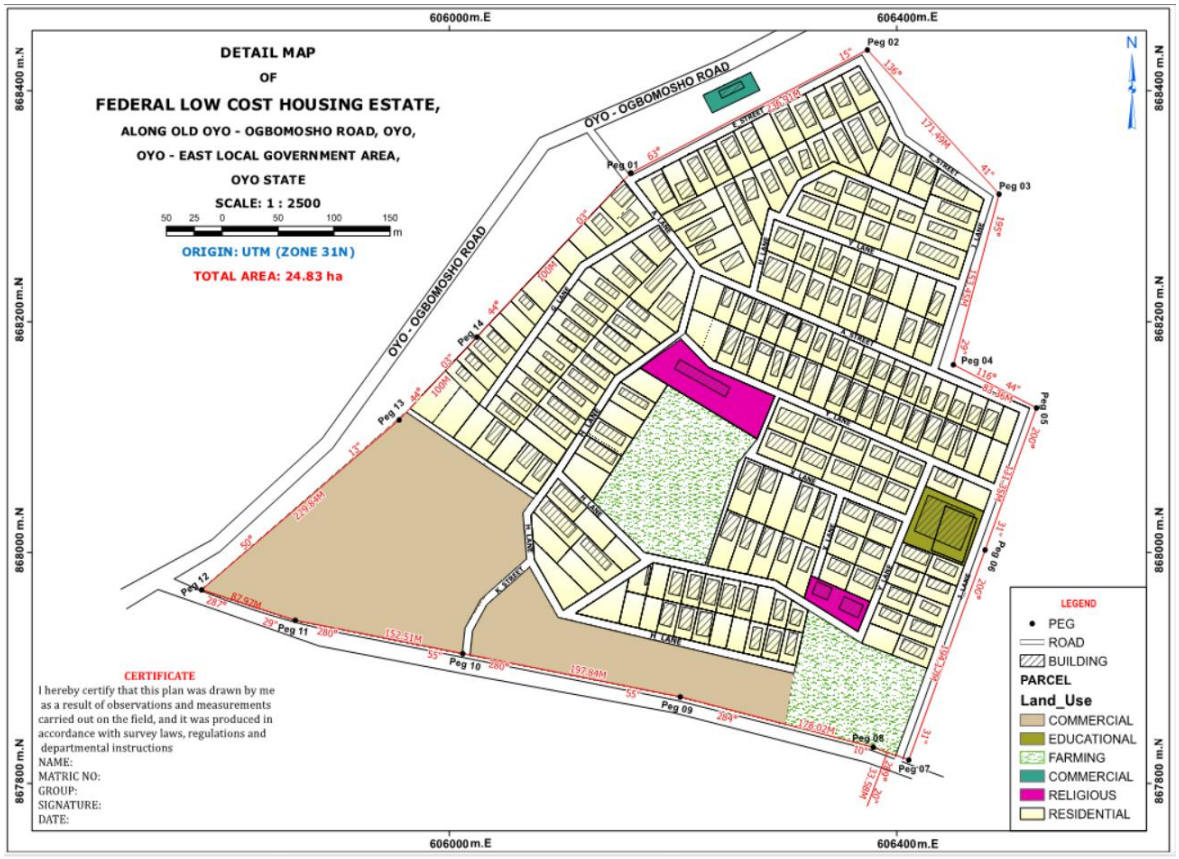

Figure 7: Map showing the spatial details within the study area.

Also relational table was created to link the spatial and a-spatial components of the database.

Table

PARCEL

OBJECTID *	Shape *	Shape_Area	Easting	Northing	P_Block	P_Owner	P_Owner_Occ	Land_Use	Elect_Supply	P_Status	O_Sex	Shape_Length	Area
2	Polygon	632.437995	606437.171676	606437.171676	C	AKEEM ADELOWO	TEACHING	RESIDENTIAL	YES	DEVELOPED	M	106.327547	632.437995
3	Polygon	617.161958	606420.360679	606420.360679	C	AZEEZAT ARIKE	FARMING	RESIDENTIAL	NO	UNDEVELOPED	F	104.630396	617.161958
4	Polygon	601.883589	606403.549801	606403.549801	C	ABIMBOLA GAFAR	FARMING	RESIDENTIAL	NO	UNDEVELOPED	M	102.933009	601.883589
5	Polygon	699.795131	606365.398687	606365.398687	A	MUMINAT TAIWO	FARMING	RESIDENTIAL	YES	DEVELOPED	M	110.992279	699.795131
6	Polygon	647.999087	606348.476898	606348.476898	A	ADEBIMPE ADEBUNMI	FARMING	RESIDENTIAL	YES	DEVELOPED	M	107.999938	647.999087
7	Polygon	647.999071	606332.4133	606332.4133	A	ADUNNI OLUFUNKE	DRIVING	RESIDENTIAL	YES	DEVELOPED	F	108.000018	647.999071
8	Polygon	648.004959	606316.34966	606316.34966	A	AKANFE OLUBUNMI	DRIVING	RESIDENTIAL	YES	DEVELOPED	F	108.000372	648.004959
9	Polygon	1220.362232	606434.21677	606434.21677	B	OLUWATOLA OLUKUNMI	RETIREE	RESIDENTIAL	YES	DEVELOPED	F	147.636289	1220.362232
10	Polygon	647.998074	606300.28598	606300.28598	A	AYOOLA LYDIA	TRADING	RESIDENTIAL	YES	DEVELOPED	M	107.99968	647.998074
11	Polygon	647.99809	606284.222382	606284.222382	A	ADESUMBO IFEDEJI	TRADING	RESIDENTIAL	NO	UNDEVELOPED	M	107.999799	647.99809
12	Polygon	648.000773	606268.158722	606268.158722	A	ADEBOWALE AYANFE	LAWYER	RESIDENTIAL	YES	DEVELOPED	M	108.000044	648.000773
13	Polygon	648.001533	606252.095093	606252.095093	A	ADIO GAFAR	MECHANIC	RESIDENTIAL	YES	DEVELOPED	M	108.000209	648.001533
14	Polygon	647.998575	606236.031494	606236.031494	A	AJANI IBRAHEEM	MECHANIC	RESIDENTIAL	YES	DEVELOPED	M	107.999963	647.998575
15	Polygon	648.001781	606219.967865	606219.967865	A	OLAKUNLE JUBRIEL	MECHANIC	RESIDENTIAL	YES	DEVELOPED	M	108.000018	648.001781
16	Polygon	647.997088	606203.904205	606203.904205	A	AGUNBIADE TAIWO	VULCANISER	RESIDENTIAL	YES	DEVELOPED	M	107.999798	647.997088
17	Polygon	800.468071	606185.390053	606185.390053	A	OLAKUNMI DAVID	LAWYER	RESIDENTIAL	YES	DEVELOPED	M	117.26752	800.468071
18	Polygon	945.397212	606216.686684	606216.686684	A	DUROJAYE MUHAMMED	LAWYER	RESIDENTIAL	YES	DEVELOPED	M	141.442728	945.397212
19	Polygon	876.838964	606226.503024	606226.503024	A	AZEEZ AMAO	BARBING	RESIDENTIAL	YES	DEVELOPED	M	133.825101	876.838964
20	Polygon	808.285744	606236.31859	606236.31859	A	TAIWO GABRIEL	BARBING	RESIDENTIAL	YES	DEVELOPED	F	126.298118	808.285744
21	Polygon	962.36462	606251.915658	606251.915658	A	GABRIEL GBOLAHAN	BARBING	RESIDENTIAL	YES	DEVELOPED	F	133.626026	962.36462
22	Polygon	619.608145	606379.928647	606379.928647	A	AJAYI OLUKUNLE	RETIREE	RESIDENTIAL	YES	DEVELOPED	F	107.031474	619.608145
23	Polygon	823.440301	606366.569131	606366.569131	A	OMOWUMU DEBORAH	DRIVING	RESIDENTIAL	YES	DEVELOPED	F	133.050806	823.440301
24	Polygon	-771.980374	606351.054877	606351.054877	A	FUNKE ADEDOTUN	DRIVING	RESIDENTIAL	YES	DEVELOPED	F	131.369578	-771.980374
25	Polygon	509.067583	606330.983947	606330.983947	A	MUHAMMED AISHAT	FARMING	RESIDENTIAL	YES	DEVELOPED	F	98.444391	509.067583
26	Polygon	502.814026	606314.700055	606314.700055	A	AJANI MUDRAT	FARMING	RESIDENTIAL	YES	DEVELOPED	F	91.869361	502.814026
27	Polygon	570.75253	606299.125461	606299.125461	A	ADEKUNLE FATAI	FARMING	RESIDENTIAL	YES	DEVELOPED	F	104.023652	570.75253
28	Polygon	752.604162	606285.589066	606285.589066	A	AJANI OLUFUNKE	FARMING	RESIDENTIAL	YES	DEVELOPED	F	118.206081	752.604162
29	Polygon	834.003834	606270.259034	606270.259034	A	KAREEM IBIWUMI	FARMING	RESIDENTIAL	YES	DEVELOPED	F	141.944631	834.003834
30	Polygon	856.489953	606389.698808	606389.698808	A	ADEDUNTAN DARAMOLA	FARMING	RESIDENTIAL	YES	DEVELOPED	F	133.685874	856.489953
31	Polygon	653.699698	606406.293233	606406.293233	A	IFEDAPO JOY	FARMING	RESIDENTIAL	YES	DEVELOPED	F	109.215251	653.699698
32	Polygon	587.27694	606422.305967	606422.305967	A	OLAOLUWA MICHEAL	FARMING	RESIDENTIAL	YES	DEVELOPED	F	101.834896	587.27694
33	Polygon	834.661498	606450.616445	606450.616445	A	ED	FARMING	RESIDENTIAL	YES	DEVELOPED	F	131.309819	834.661498
34	Polygon	859.110314	606447.077759	606447.077759	B	OKIKIOLA RAHMAT	FARMING	RESIDENTIAL	YES	DEVELOPED	M	131.463699	859.110314
35	Polygon	561.438085	606407.425529	606407.425529	B	ALAO KEHINDE	BRICKLAYING	RESIDENTIAL	YES	DEVELOPED	M	94.9424	561.438085
36	Polygon	590.728115	606384.103809	606384.103809	B	AMAO BILIAMINU	TEACHING	RESIDENTIAL	YES	DEVELOPED	M	97.285691	590.728115
37	Polygon	642.004325	606335.978174	606335.978174	B	AKINKUNMI ALAO	RETIREE	RESIDENTIAL	YES	DEVELOPED	M	106.525047	642.004325
38	Polygon	624.994891	606352.446899	606352.446899	B	OKANLAWON RAZAQ	LECTURING	RESIDENTIAL	YES	DEVELOPED	M	99.999591	624.994891
39	Polygon	624.999142	606375.971814	606375.971814	B	ABDULLAHI MARYAM	LECTURING	RESIDENTIAL	YES	DEVELOPED	M	99.999931	624.999142
40	Polygon	571.344917	606369.928067	606369.928067	C	ABDUL MOJEED ADEWALE	LECTURING	RESIDENTIAL	YES	DEVELOPED	M	99.539602	571.344917

(0 out of 227 Selected)

Figure 8: Screenshot showing the database created for the parcels within the study area.

4.1 Sample Queries

The database created is then used for implementing several selection queries in determination of user-defined requirements such as parcels whose occupiers are actual owners, occupier's occupation, number of residents in each flat, selection of unoccupied flats and other such security related questions. Single and Multi-Criteria queries were performed such as;

- Query showing defaulters of the building code i.e. those that developed more than 45% of the parcel.
- Query showing results of multi-criteria query selecting parcels with C of O whose owners are civil servants.
- Query showing results of multi-criteria query selecting owners that are not civil servants along A-Lane etc.

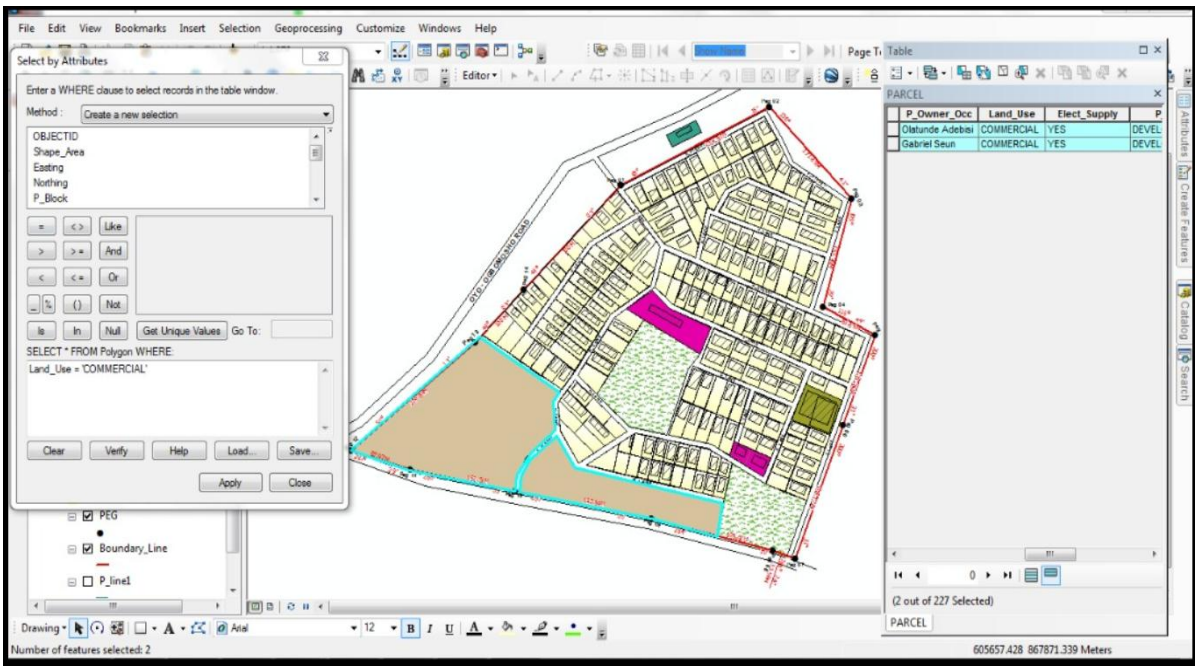

Figure 9: Showing multi-criteria query selecting developed parcels and used for commercial purposes.

5.0 CONCLUSION

This study has presented the possibilities for efficient implementation of a Cadastral Information System for Federal Low Cost Housing Estate in a GIS environment. Logical and Physical models for the cadastral Information System have been effectively built and utilized in the creation of the Cadastral Information System using an Entity relationship model. Such Information System has proven efficiency and could provide for Property Valuation within the estate, Residents Inventory for efficient security maintenance, Miniature Digital Cadastre

of title and interests in land within the estate, Property holding and leasing analysis, Documentation of revenue from land taxation; etc. with this it can be seen that Government at all levels has a lot that can be generated internally on land apart from the country's almighty crude oil in terms of revenue and could be managed through an information systems.

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