The Role of Geographic Information System in Urban Land Administration in Nigeria

Abstract

Geographic Information System (GIS) is a configuration of computer hardware, software and data specifically designed to capture, store, analyze, manipulate, edit, retrieve and display spatially referenced data. Being a computer-based system, GIS is a robust, reliable and versatile technology that can be adopted in managing both spatial and attribute data in text and graphic form thereby making it most suitable for land administration purposes. This paper posits that the current manual system of filing, recording, storing and retrieval of information relating to land can no longer be sustained in the face of the rising growth of information technology. It asserts that the adoption of GIS technology in land administration will facilitate timely title registration, provide tenure security, ease land application processes and information sharing, facilitate land transactions, reduce corruption associated with land dealings, create efficient land markets and serve as a decision support system to government at all levels in formulating policies relating to land. The paper therefore advocates for the immediate computerization of all land records using GIS technology as an imperative for efficient and effective urban land administration in Nigeria.

Keywords: Geographical information system; Land administration; Spatial data; Database

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Introduction

The importance of land to the growth and survival of man can hardly be overemphasized. Land is indeed a very crucial resource to man as it provides the base for all developmental activities. In most countries of the world, land constitutes a substantial portion of a nation's wealth. Efficient management of this vital resource is therefore essential for the overall sustenance and development of man.

Land administration as part of the overall process of land management, has been described in the report of the United Nations Land Administration Guidelines [1] as the "process of determining, recording and disseminating information on ownership, value and use of land when implementing land management policies". According to Dale [2], land administration includes the determination (sometimes known as adjudication) of rights and other attributes of the land, the survey and description of such lands, their detailed documentation and the provision of relevant information about the land and any property attached to it.

Implicit in the above definition is the need for a sound and reliable information base that would support planning, development and management activities by government. The efficient and effective administration of land as well as its associated resources is therefore hugely dependent on the availability of good land information system.

In the light of the evolving digital technology or information technology revolution, most countries of the world have begun the computerization of their land records into digital formats thereby creating sound land information systems (LIS), with capacity of providing on-line access to a comprehensive set of land and property information.

Unfortunately, most land administration agencies in Nigeria continue to rely heavily on the manual system of filing, recording, storing and retrieval of information relating to land within their jurisdictions [3]. According to Ali et al. [4], the existing manual land information system, which is entirely based on maps and records on paper formats with no cartographic standards and often out-dated information, can no longer be sustained in an emerging information society.

The problems of land administration in Nigeria is further accentuated by the lack of a uniform system for land administration in the various states of the Federation due to the operation of the Land Use Act, which vests land in each state on the Governor. Thus each state has its own system and procedures for land administration making the entire country have a non-uniform system in the administration of land.

Geographic Information System (GIS) therefore presents itself as a robust, reliable and versatile technology that can be used in managing land records. Although GIS has been used extensively in environmental resources management, it has had limited use

in land administration particularly in developing countries. This perhaps explains why in Nigeria, many land registries are yet to implement the GIS technology. Its adoption and implementation in the management of land records is fundamentally important for effective and efficient urban land administration practice, which is crucial for sustainable development in Nigeria.

Meaning and Nature of Geographic Information System

The term geographic information system (GIS) has been defined in several ways by different scholars with each definition tilted towards the perception and professional orientation of the person defining it. Hence, there is no universally accepted definition of GIS. Attempt has been made in this paper to review some of those definitions to enable a deeper understanding of GIS to be made.

Burrough [5] defines GIS as a "set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes". This definition clearly shows that GIS is a means to an end which is simply to achieve a "set of purposes".

Aronoff [6] on the other hand defined GIS by looking at the major operational stages involved. According to him GIS is a "computer based system that provides four sets of capabilities to handle geo-referenced data: data input, data management (data storage and retrieval), manipulation and analysis and data output".

Star et al. [7] defined GIS as an "information system that is designed to work with data referenced by spatial or geographic co-ordinates". This definition though brief highlights the fact that most of the data that the GIS uses are geo-referenced data. That is, data tied to some geometric coordinates on the surface of the earth.

Tomlin et al. [8] views GIS as a "configuration of computer hardware and software specifically designed for the acquisition, maintenance and use of cartographic data" This definition undoubtedly reveals one of the unique functions of GIS which is map making. Hence, GIS is perceived to be an advanced cartography.

Geographic Information System (GIS) has also been defined as a system of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth [9]. According to the Environmental Systems Research Institute [10], a GIS is an "organized collection of computer hardware, software, geographic data and personnel designed to effectively capture, store, update, manipulate, analyze and display of all forms of spatially referenced information". On the other hand, Fabiyi [11] describes GIS as a "unique integration of computer hardware, software, peripherals, procedural techniques, organizational structure, people and institution for capturing, manipulating, storing, analyzing, modulating, modeling and displaying geographically referenced data for solving complex human related problems".

From the analysis of the above definitions, it is obvious that GIS is a computer-based system that is used for mapping and analyzing spatial features on the earth's surface. It is also indicative from the various definitions that GIS is an interdependent system consisting of the following components namely computer hardware, software, geographic data, expertise and procedures. No component can operate in isolation of the other and a careful integration of all is vitally important for the successful functioning of GIS.

Irrespective of the definition one is giving or adopting, it must be realized that GIS is a peculiar technology with the essential features of spatial references and data analysis. Hence, the true power of GIS lies in its ability to integrate information and to help in making decisions. A GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

GIS is an information system designed to work with data referenced by spatial/geographical coordinates. In other words, GIS is both a database system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. It may also be considered as a higher order map. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies [10].

Many professionals, such as foresters, urban planners, and geologists, Estate surveyors and valuers have recognized the importance of spatial dimensions in organizing and analyzing information. Whether a discipline is concerned with the very practical aspects of business, or is concerned with purely academic research, geographic information system can introduce a perspective, which can provide valuable insights as:

a. 70% of the information has geographic location as its denominator making spatial analysis an essential tool.

b. Ability to assimilate divergent sources of data both spatial and non-spatial (attribute data).

c. Visualization Impact

d. Analytical Capability

e. Sharing of Information

In a nutshell, GIS is a special-purpose digital database in which a common spatial coordinate system is the primary means of reference. A full-fledged, comprehensive GIS has dedicated facilities or subsystems for:

a. Data input, from maps, aerial photos, satellites, surveys, and other sources

b. Data storage, retrieval, and query

c. Data transformation, analysis, and modeling, including spatial statistics

d. Data reporting, such as maps, reports, and plans [7,12].

Maguire [12] identifies three perspectives of describing GIS, namely, identification, technological and organizational perspective. The identification perspective describes the unique features of GIS that distinguish GIS from other types of information systems, giving GIS its special identity to justify separate attention needed during its implementation. The technological perspective tends to gravitate towards four different approaches. The first of these is a process or function oriented approach. This approach emphasizes the information handling capabilities of GIS. A second approach is an application approach, with focus on the applications of GIS and the problems they attempt to solve. The third approach, which is probably the most widely used is, the toolbox approach. This approach emphasizes the generic aspects of GIS as a toolbox to manipulate spatial data [13]. The fourth approach is the database-oriented approach, which regards GIS as a database system, reflecting the influence of database theory and practice on GIS.

GIS Capabilities

GIS has capabilities to perform a whole range of activities so long as such activities are in one way or the other related to the earth's surface. Location is therefore of essence. According to Burrough [5,6,10], a deeper understanding of GIS can be made by looking at the type of questions that the technology can or should be able to answer. Generally, GIS can be used to address concerns relating to location, condition, trends, patterns, modeling, spatial questions as well as non-spatial (Attribute) data.

Accordingly, five broad types of questions that a sophisticated GIS can answer have been identified as follows:

a. Location: What is at...?

This question seeks to find out what exists at a particular location. A location can be described in many ways, using, for example place name, post code, or geographic reference such as longitude/latitude or x/y.

b. Condition: Where is it...?

In this question, instead of seeking to identify what exists at a given location, one may wish to find location(s) where certain conditions are satisfied (e.g., all rentable 3-bed room apartments in a neighbourhood, sites suitable for the construction of a cement industry, an unforested section of at least 2000 square meters in size, within 100 meters of road, and with soils suitable for supporting buildings)

c. Trends: What has changed since...?

This question involves seeking to know what has changed over a given period of time, as well as the magnitude and spatial pattern of such a change (e.g. change in land use or elevation over time).

d. Patterns: What spatial patterns exist...?

This question is more sophisticated. One might ask this question to determine whether, for instance, landslides are mostly occurring near streams. It might be just as important to know how many anomalies there is that do not fit the pattern and where they are located.

e. Modeling: What if...?

"What if…" questions are posed to determine what happens, for example, if a new road is added to a network or if a toxic substance seeps into the local ground water supply. Answering this type of question requires both geographic and other information (as well as specific models). GIS permits spatial operations.

f. Non-spatial Questions: "What is the average number of people working as Estate Surveyors and Agents in each location?" is an aspatial question - the answer to which does not require the stored value of latitude and longitude; nor does it describe where the places are in relation with each other.

g. Spatial Questions: "How many people work with Estate Firms in the major urban centres of Lagos Metropolis? OR "which centres lie within 10 Kilometres of each other?" OR "what is the shortest route passing through all these centres". These are spatial questions that can only be answered using latitude and longitude data and other information such as the radius of earth. Geographic Information Systems can answer such questions.

GIS is basically a computer-based system for comprising hardware, software, geographically referenced data, people and procedures logically arranged to store, retrieve, manipulate, analyze, update and output data (as information), for decision making. This way, GIS should be rightly seen as a powerful decision support system (DSS).

A GIS is thus seen as both a database system with specific capabilities for spatially referenced data as well as a set of operations for working with the data. It may also be considered as a higher order map. GIS can be used to address concerns relating to location, condition, trends, patterns, modeling, spatial questions, as well as aspatial (non-spatial) questions. It is a digital technology that combines the visual appeal of conventional maps with database operations and statistical analysis [12].

The Role of GIS in Land Administration

Land administration essentially entails a number of processes meant at ensuring that land rights are properly delineated and recorded. It involves all those processes whereby information relating to land ownership, land use and land value are properly documented. Generally, these processes often result in large volumes of information. This information covers issues relating to master plan, land use plans, detailed site development plans, engineering infrastructure as well as other survey information, records of allocation (name of allottees, plot numbers, plot sizes, use and locations), records of all transaction such as power of attorney, deed of assignment, mortgages, subleases, releases, devolution and so on. All these information are practically difficult to manage using the traditional/manual approach.

GIS, being a computerized system, has capabilities in handling such huge amount of data in a manner that is not only effective, but efficient, secured, faster and transparent. Data handled by a GIS can be spatial or attribute data. Spatial data relates to data that has locational or positional identity with respect to the surface of the earth while attribute data describes the characteristics or qualities of spatial features. This implies that a GIS may have a property parcel described in its spatial database and qualities

such as its land use, ownership, property valuation and so on in its attribute database.

Some of the advantages of computerization of land administration systems as outlined by Adamu [14] include the followings: -

a. Increasing the speed of processing title and reducing time and cost in the process of obtaining title to land.

b. Providing public access to information relating to land.

c. Entrenching transparency in land administration practices.

d. Integrating land record information with other services.

e. Improving collection of property taxes.

f. Controlling of double allocation and un-authorized use of land.

g. Simplifying application forms and processes.

h. Reducing the influx of illegal intermediaries.

The adoption of GIS technology can potentially lead to the development of efficient and organized land markets, guarantee tenure security among land owners, increase revenue generation by government, reduce disputes among land owners as well fostering prudent land management by establishing efficient system of land administration [15,16].

Computerized land information system through GIS is therefore seen as the most appropriate technology in the reformation of cadastral systems and land administration all over the world [17]. According to Nuhu [18], GIS is one of the modern methods that could be used in the computerization of land records as well as enhancing the process of land registration in Nigeria. This underscores the reason why many states governments in Nigeria are beginning to adopt GIS in their land administration processes. With the success story of the Abuja Geographic Information System (AGIS), other states such as Lagos, Niger, Bauchi, Benue, Cross River, Nasarawa have also established their respective GISs. The adoption of GIS technology in land administration and management is intended to provide accurate and reliable information on all land and buildings that are captured into the system.

Practical benefits of using GIS in land administration

The adoption of GIS for land administration purposes will undoubtedly bring a lot of benefits and promote sustainable national development in the country. Some of the notable benefits have been outlined below:-

a. A GIS based land administration system will facilitate data processing, storage and retrieval of land records and provide secured geospatial data infrastructure for all land matters.

b. It will facilitate easy completion of land registration processes which at the moment takes longer time to complete in most states of the federation;

c. Guarantee secured land rights to land owners since details of all land parcels will be captured in the GIS spatial database. According to UNECE [1], there can be no sustainable development without secured land rights.

d. GIS land- based titles are considered secured hence provide security for credits for land owners by banks. This has a value added chain particularly in the housing, construction and financial sector;

e. It will decrease the cost and space required for storing land records. Depending on the hardware and storage capability of the computer, a whole lot of data can be stored in them with backups made in case of system breakdown. The wear and tear of graphical information such as maps and layouts can be eliminated completely.

f. Since each land parcel is unique in its location having distinctive geographic coordinates, the issue of double allocation of plots as is common with the current practice will become a thing of the past. Hence the system will engender transparency in land administration system;

g. Increase revenue to government through the re-validation of titles by land owners, consent fees, deed of assignment, deed of mortgage, deed of lease, power of attorney, sales of hardcopy maps etc.

h. GIS allows for spatial and attribute query as well as spatial searches through a very effective and efficient Database Management System (DBMS) embedded in the GIS infrastructure. It will ease property searches and facilitate land transactions. The long period of time it takes to verify title to land will be drastically reduced. Search fees paid in the process will also yield revenue to government.

i. It will encourage land transactions in the formal markets since every potential buyer will want to verify from the GIS whether the title to the land is genuine and free from any encumbrances. Without reliable registers, transaction in land is often costly, time consuming and uncertain.

j. The system will reduce to the barest minimum cases of land disputes. The GIS records all the particulars of the owner of a given parcel of land as well as the geometric dimension of the land parcel. By so doing, it is difficult for two people to lay claim to the same piece of land. Integrity checks built in the DBMS ensures that database is not unduly tampered with.

k. Being a land repository, the data held in the GIS database will be of immense benefit to government for planning and developmental purposes. E.g. taxation, housing, transportation etc.

l. The GIS allows the concurrent use of data by different users at a time. Hence, allows for information sharing among different users.

Recommendations

If GIS is to be successfully implemented for purposes of effective land administration in Nigeria, the following recommendations must be adhered to:-

a. There is need for the various state governments to establish their state's Geographical Information System or Service that will be vested with the statutory powers to create a geospatial data infrastructure for land administration.

b. Adequate needs assessments should be undertaken to determine work flow and processes as well such data that will be required for the successful implementation of GIS.

c. Adequate funds should be budgeted for the acquisition of the necessary hardware, software and other peripherals required for the establishment of a geographical information system.

d. Capacity training for staff members in all land registries that will be directly and indirectly involved in the implementation of the new system.

e. There is also the need to engage the right professionals at the various stages of GIS implementation namely planning, development and operational stages.

f. There is need for enlightenment campaigns to acquaint the general public on the relevance of computerization of land records as well as its inherent benefits to all.

g. Finally, it is recommended that title documents emanating from the exercise in respect of land parcels should be printed on special security papers that will make it almost impossible to forge. By so doing, trust and confidence will be built in the system by all and sundry.

Conclusion

Efficient and effective urban land administration depends on the availability of good, reliable and timely information. This information can be guaranteed through the computerization of land records using the GIS technology. The manual approach of keeping land records in most land registries in the country can no longer be sustained in this era of information revolution due to its inherent problems. If Nigeria is to achieve sustainable development, urgent steps must be taken to digitized its land records and build a national land information system or service that will foster the growth of organized land markets, guarantee tenure security, reduce land disputes and increase the revenue generating potential of government.

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