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DEVELOPMENTOF GEOGRAPHIC INFORMATION SYSTEMS BASED FACILITY MANAGEMENT OF AREA F STAFF HOUSING UNIT, AHMADU BELLO UNIVERSITY ZARIA, NIGERIA

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ABSTRACT
The research critically observed the process and methods involved in developing a GIDFM in A.B.U Zaria. In order to achieve the aim and objective of this research, Satellite images, Area F base map, coordinates and control points of the houses, attribute data of the houses such as a general information of the house, record of the surrounding environment, maintenance information about the houses all of which were collected through distribution of questionnaires to the occupants of the houses and visual inspection by the researcher and used to obtained the final results for the study. Multiple approaches of both ArcGIS 10.3 and questionnaires were employed. It was found that, there were 160 housing units in Area F. The study also shows that, one third of the infrastructure and facility of the housing units were in bad conditions and not properly managed. The study hereby recommends that there is the need for proper management of the infrastructure and facility in the housing units in order to enhance optimal performance of occupants at their various workplaces. Thus, GIS is an important tool in facility management.

Keywords: Facility, Management, Housing, Development and GIS.

INTRODUCTION

Geographic information System (GIS) is described as a tool that deals with the acquisition, processing and management of geo-information. It is the science and technology for the acquisition, storage, analysis, manipulation and dissemination of geo-information. GIS is defined as a computerized tool for capturing, storing, checking, integrating, manipulating, analyzing and displaying of data which are spatially referenced towards an effective decision making (Chang, 2010). GIS is a great way of maintaining the land and asset portfolio, links data from many data sources, allows better decision making and time resources, distributes data to many people and other systems (McLaughlin and Coleman, 2009).

GIS based information systems are computer programs that store, analyze and present information about the facilities of an enterprise. For example, a complete data about certain houses with some peculiar maintenance issues can be seen by just a button-click. Maintenance and space planning are easier to simulate by getting the relevant data on the screen. Another point is the approach to optimize building cleaning specifications by offering complete and actual measuring of floors and windows. The GIS based information system helps the facility managers to rationalize works and to provide the translucency for all processes and costs that arise in the residential buildings of the whole study area. In order to deal with these tasks, a GIS Based information system has to contain and generate a lot of different information for ease of maintenance and management (Kufoniyi. 1998).

University infrastructural facilities such as residential houses, classes, student hostels, laboratories, sporting areas etc are components making the University a system that functions as a community to house staff and students in efforts to provide qualitative teaching, learning and research services. Geographic information system ties together the entire components in the University as a system that can be used for planning, management and to aid decision making processes within the University (Masser, 2000). The facility manager also cares about cost statements for heating, electricity and water.

The applications are not exhaustive; GIS has more advantages than the analogue way of keeping the tracks of information in the University because the spatial database is directly linked to the spatial entities on the map of the university at large. Estate information managed with GIS is more versatile because it can be subjected to many applications without introducing errors (Ferreira and Flintsch, 2004).

On the same view, John (2002) stated that the data may be map-oriented, which comprise qualitative attribute of an area recorded as line, points and area (polygons). Lines, points, and polygons are used in a vector format. A second type of format is image oriented, the data in this format has quantitative attribute referring to cells in a rectangular grid.

Public and private agencies have always tried to maintain their infrastructure assets in good and serviceable condition at a minimum cost; therefore, they practice infrastructure and facility management. However, as most of the nation's infrastructure and facility management systems reached maturity and the demands placed on them started to rapidly increase in the mid- 1960s, infrastructure agencies started to focus on a systems approach for infrastructure management. This process has led to today's Asset Management concept in Melbourne (Rajabifard *et al*., 2002).

According to (Odediran *et al.,* 2012) despite decades of evolution of building infrastructure design, construction and maintenance in Nigeria, the country is still faced with a myriad of fundamental problems and challenges in the industry especially, in the facility maintenance business of building

infrastructure. The challenges can be grouped into the following broad categories: Socio-cultural challenges and Technical challenges. There are several technical challenges that have militated against effective facility maintenance of building infrastructure in Nigeria. These technical challenges include: Building design flaws; errors during building construction; poor defect diagnostic ability and limited technical knowledge; weak standards and poor enforcement of standards; poor quality of building materials and economic challenges.

Due to the high usage and importance of Spatial data in planning, management and decision-making in attaining prompt and precise results, there is a particular need to facilitate creation of spatial data infrastructures (SDI) through geographic information system (GIS) in ABU, Zaria, as a core activity within this broader strategy with aims to having it as a system easily available for usage at any point in time. GIS based information system is thus the best solution for infrastructure and facility management and prompt decision making in the effective management and Maintenance for the university. It is against this background study developed Geographic Information Systems database for facility management of area F staff housing unit, Ahmadu Bello University Zaria, Nigeria.

In Ahmadu Bello University, Zaria today, it is difficult to obtain information about piped water distribution network, the physical conditions of houses in the staff quarters, schedule of dilapidation and renovations of the staff quarters etc. Such information may be available in different places, but not integrated into a unified information system for ease of documentation, query, and for better analysis to best inform the decision making process.

Data management faces many challenges today in terms of facility and infrastructural management in ABU, Zaria. This perhaps makes it very necessary to provide a system that brings together all facilities and infrastructures and any other spatial infrastructure under the supervision of the Estate Department of the University. This will help in solving the problems of availability of data for planning.

Based on the literature reviewed, most of the studies were carried out outside the study area to the best of the researcher's knowledge; there is no research that has been conducted in the study area with the aim of developing Geographic Information Systems database for facility management of area 'F' staff housing unit, Ahmadu Bello University Zaria, Nigeria. It is against this background this study aimed to study developed Geographic Information Systems database for facility management of area 'F' staff housing unit, Ahmadu Bello University Zaria, Nigeria. It was achieved through the objectives are to develop a digital map of the area, create geodatabase of the area and evaluate the entire Geographic Information Systems database for decision making.

The Study Area

Area 'F' staff Housing is a residential area accommodating the senior staff of Ahmadu Bello University Zaria as show in Figure 1. It contains one hundred and sixty houses (160) and were all built in the year 1972. Area F Residential area is within the walls of Ahmadu Bello University main campus and lies on latitude $11^0$09'20"N to $11^0$09'55"N and longitude $7^0$37'25"E to $7^0$38'00"E covering about 556,800m^{2}within the Northern Guinea Savannah Vegetation and having altitude of 685m above sea level.

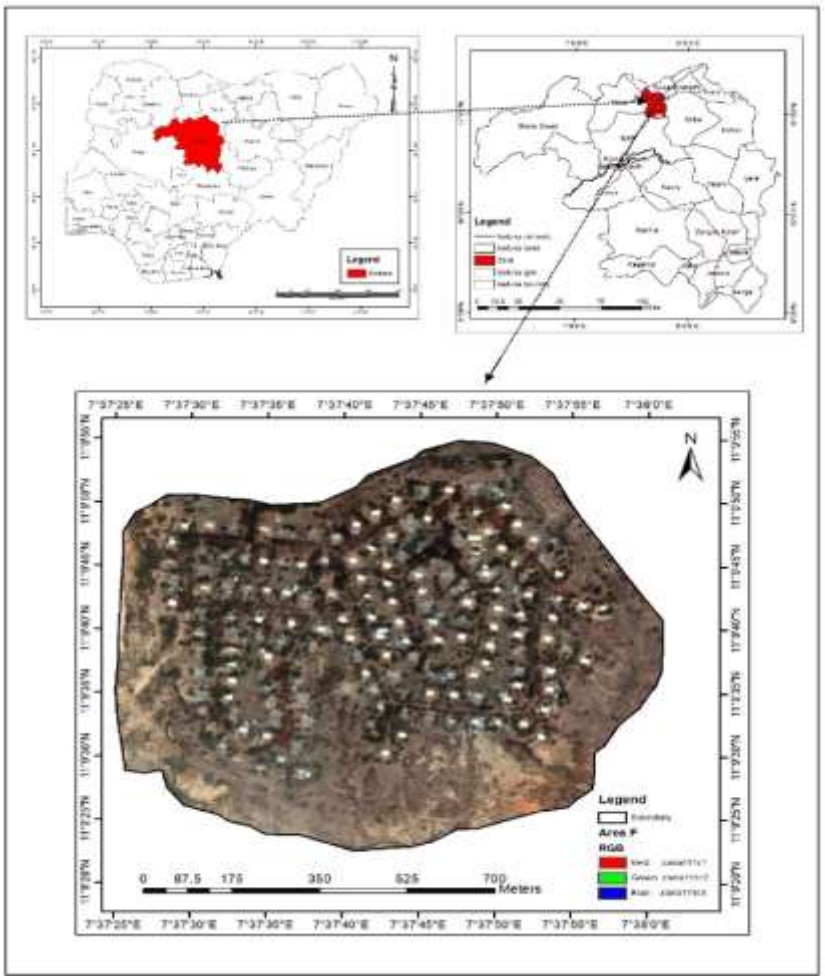

Fig. 1: Map of study Area
Source: Modified from Quickbird image (2013)

Ahmadu Bello University Zaria was officially established on October 4th 1962. It is the largest academic institution in the country. It covers a land area that is over 21 km^2 (2,133 Ha), the average part of which is under developed. Area F housing unit is 14 km North-west of Zaria is bounded on the North by a tributary of Kubani River, to the South by the Faculty of Agriculture, to the East is Area BZ housing area and to the West is Area G Housing Unit respectively.

MATERIALS AND METHODS

Reconnaissance survey of the study area was carried out to become familiar with the study area. Discussions was carried out with various staff of the Estate Department who serve as the facility managers of the University as to the type of information needed mostly for planning and management of the facilities and infrastructures.

The types of data used for the study includes: Coordinates and control points of the houses; Digital picture of the houses; Attribute data of the houses which include water, well condition; Record of the surrounding environment; Maintenance information about the houses and Satellite image and guide map of the study area.

These data were Sources from both the Primary and secondary Source. The Primary data was obtained through ground truthing by taking the coordinates and control points of the houses for geo-referencing purposes using GPS. The digital picture of the houses was also captured to give a pictorial view when assessing the conditions of the houses using a digital camera. It also constitutes the attribute data of the houses; include a general information of the house, record of the surrounding environment, maintenance information about the houses all of which were collected through distribution of questionnaires to the occupants of the houses. The secondary data sourced were Satellite image and guide map of the study area were obtained from Estate Department of ABU, Zaria which was scanned and digitized such that the number of each house shows on the box representing the house and its surrounding perimeter.

Data Collection Procedure: The imagery of the study area was downloaded from Quikbird website (downloaded from global land cover website). The image provides information on which the base map for the study area was generated. The base map provided information on the structures in the study area. Attribute data was collected through field work involves the administration of questionnaires. The data obtained include

personal information, Maintenance information and Environmental conditions of the houses in Area F.

Sampling Size and Sampling Techniques: The entire house of Area F housing units numbering 160 was covered for this study. Detailed questionnaires were administered to the house head or his/her representatives.

Materials used

The Hardware used includes:A hand-held Garmin 76CSX GPS was used during field work for capture of control points of Area F Housing unit; A digital camera was used for the capture of picture of the houses; A Laptop computer (3 GHz) at 500 GB Disc Space HP DV6 was used for processing all the information gathered in this study; An A4 scanner was used to scan hardcopy of the guide map of the study area; An A4 printer was also used to print out hardcopy of the GIS based infrastructural and facilities information management system query and map points.

The Software used include: Microsoft Word 2013 was used for documenting the research work.

ESRI ArcGIS 10.1 software was used as for the creation geospatial database, querying and production of map, chart and tables of the conditions of facilities and infrastructure in the study area.

Method of Data Analysis: All data collected were analyzed using the following procedures:

Develop a digital map and geodatabase of the area: to achieve that, two procedures were followed; these are, georeferencing and digitizing of the administrative and based map of the study area. Georeferencing: In order to use these types of data (administrative map of the study area and housing units) in GIS it is necessary to align it with existing geographically referenced data, this process is also called georeferencing. Georeferencing is also a necessary step in the digitizing process for the administrative map of the study area. The shapefiles, attributes and imagery for this research were all stored within the Geodatabase.

Digitizing: this is the process of converting or obtains the housing information from the satellite imagery. This is done by tracing the building footprint from the satellite imagery through the shapefiles created in the ArcGIS. After the digitizing process attribute tables would then be attached through the join and relationships from which the Query are generated.

Analyze the attributes such as; staff housing, electricity, water and road of the geodatabase based on variables: The attributes were analyzed using query lanquage in the ArcGIS environment. Query analysis were employedin other to determine the housing condition from the data collected a series of query were performed to analyse and visualize the housing condition in Area F. Query is the process of questioning the attribute or information of a feature from the database using a sequential Query Language SQL. Thus the following SQL:

```
SELECT*FROM AreaF_Maintenance INFORMATION Area WALL_CRACKS='NEED REPAIRS'
SELECT*FROM AreaF_Maintenance INFORMATION Area WALL_CRACKS='GOOD CONDITION'
SELECT*FROM AreaF_Maintenance INFORMATION Area WALL_CRACKS='GOOD CONDITION'
SELECT*FROM AreaF_Maintenance INFORMATION Area SEWAGE='BLOCKED'
SELECT*FROM AreaF_Maintenance INFORMATION Area HOUSE_FLOORING='NEED REPAIR'
SELECT*FROM AreaF_Maintenance INFORMATION Area ELECTRICAL_CONNECTION='GOOD CONDITION'
SELECT*FROM AreaF_Maintenance INFORMATION Area ELECTRICAL_CONNECTION='GOOD
CONDITION'AND PLUMBING_WORKS='GOOD CONDITION'
SELECT*FROM AreaF_Maintenance INFORMATION Area EXTENSION_FENCE"='YES'
```

Evaluate the entire Geographic Information Systems database for decision making: After the file geodatabase was created because of its common data storage and management framework for ArcGIS. It combines "geo" (spatial data) with "database" (data repository) to create a central data repository for spatial data storage and management. It can be leveraged in desktop, sever, or mobile environments and allows you to store GIS data in a central location for easy access and management. The entire Geographic Information Systems database was evaluated using functional analytical tools from the ArcGIS environment such as queries, selection by attributes and selection by location and the results were presented inform of table, map and ArcMap document.

RESULTS AND DISCUSSION

Geodatabase of Infrastructures Facility Management: Geodatabase of infrastructures facility management involves the design and building of database for infrastructures information on facility infrastructures were collected from various houses in the study area and field work. All the data collected were used as inventory for the design and building of the geodatabase in

ArcCatalog environment in ArcGIS software and some of the results are presented in Table 1 and 2 respectively.

Table 1: Some Attributes of Geodatabase of Infrastructural Table 4.2 Some Attributes of the Geodatabase of Facilities in Area F Estate. Infrastructural Facilities Management in Area F Estate.

	HOUSE_No	OCCUPANT_s_OFFICE_ADDD	DEPT_UNIT_SECTION
▸	1	Rm125,Fac_of_Arts	Theatre_Arts
	2	CERT	CERT
	3	Registry	Legal
	4	CERT	CERT
	5	DAC	SCA
	6	Fac_of_Arts	IDE
	7	Textile_Sci	Fac_of_Sci
	8	Arch	Fac_of_Env
	9	NAPRI	Diary
	10	Agronomy	Horticulture
	11	PHE	Education
	12	<Null>	<Null>
	13	Science_Educ	Geography_Educ
	14	Plant_Sci	Fac_of_Agric
	15	Surgery	Medicine
	16	Fac_of_Arts	Theatre_Arts
	17	Agronomy	Agric
	18	Geography	Fac_of_Sci
	19	Agric_Econs	Agric
	20	Samaru_FM	ABU_FM
	21	Mass_comm	Social_Sci
	22	Soil_Sci	Agric
	23	PharmacognosySTherapeutics	Pharmacy
	24	Plant_Sci	Agric
	25	Internal_audit	VC's_Office
	26	Kennedy Lib	KBL

Source: Author's Analysis 2018.

Source: Author's Analysis 2018.

Tables 1 and 2 show some of the database attribute information of infrastructural facilities with an attribute table; Attribute of each theme interrelates with the themes once the theme is active as shown above in the tables. It was found that, there are 160 housing units in area F. The results in the tables were generated from the ArcGIS database and all the information are linked to the geographic location of the facility infrastructures and having the same file geodatabase format as in the research of Micheal and Gabriela (2003). In addition, all the geodatabase is stored and can be retrieved and can be managed for decision making as the case may be. This observation supports the study by Shamsi (2005) that maintenance of accurate digital facility geospatial data is essential not only for day-today work but also for life term housing data/information management of infrastructures and facility. There is a need for a comprehensive, integrated, and up-to-date geo-database for all infrastructure, underground utilities, and facilities inventory.

Condition of The Housing Units: GIS for facility and infrastructure management were analyses in most cases with the aids of query and using selection by location and attributes tools. The results of the attributes for the geodatabase of facility and infrastructure management are shown on Figure 2 to 9 respectively.

Housing Units with and without Wall Cracks: The results of the attributes and location of wall that are cracked are show on Figure 2.

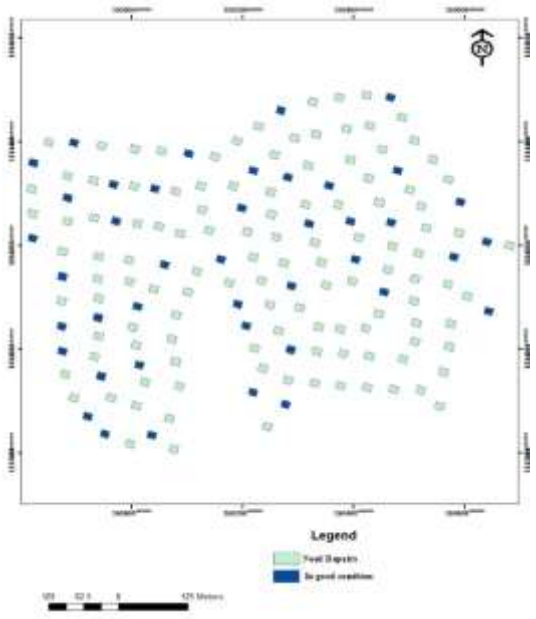

Fig. 2: The Wall Cracks and Walls without Cracks
Source: Author's Analysis 2018

The result of the query from figure 1 reveals that 73.1% of the walls of the houses in area F housing estate (the study area) were cracked and need to be repaired. As shown in Figure 2, the beryl green color locations on the figure show the houses with cracks whereas the brown color locations show the houses that have no cracks. The results were presented in form of digital map and each entity is presented as points and polygons and linked with their attribute and locations. This is one of the important of GIS in linking the spatial and non-spatial information as proposed by John (2002), the points and polygons are used in a vector format.

As show from Figure 2, only 26.9% of the walls of the houses in area F housing estate do not have cracks. The beryl green color in figure 4.2 shows the location of the houses that do not have cracks but the brown color locations show the houses that have cracks in area F estate. These is in line with (McLaughlin, 2009) which shows that GIS based infrastructure and facility management allow better decision making and time resources as well as distribute data to many people.

Several analysis using queries was carryout to examine the conditions of the following: Housing with Sewage Blockage; Housing Flooring; Housing Units with Electricity Fault; Housing Units with Plumbing Problems and Housing Units with Extension Fence among others. the queries amongst other shows that more than 38.7% of the walls of the house in area F housing estate were cracked and need to be repaired whereas 26.9 % of the wall of the houses were not cracked. It was also found that, less than one third of the sewage of house in area F housing estate were blocked whereas more than one fourth of the sewages of the houses were in good condition. The house flooring analysis reveals that more than half of the flooring in area F was in bad conditions and less than half was in good condition. Again, it was found that about one 71.3% of electric supply facilities of the houses were in bad condition while only 28.7 % was in good condition.
Moreover, it was revealed that 89.4 % of the houses in area F need plumbing work but only small proportions of about 10.6% were in good condition. Again, it was found out that less than fifty percent of the extension fences in area F were in bad good conditions and more than forty percent was in good conditions. In other locate the attributes of the infrastructure in the study area; identify tool was used to show the location and attributes of each infrastructure. Their result is presented in Figure 3 and also some information attribute information of the university staff is shown on Figure 4 and 5 respectively.

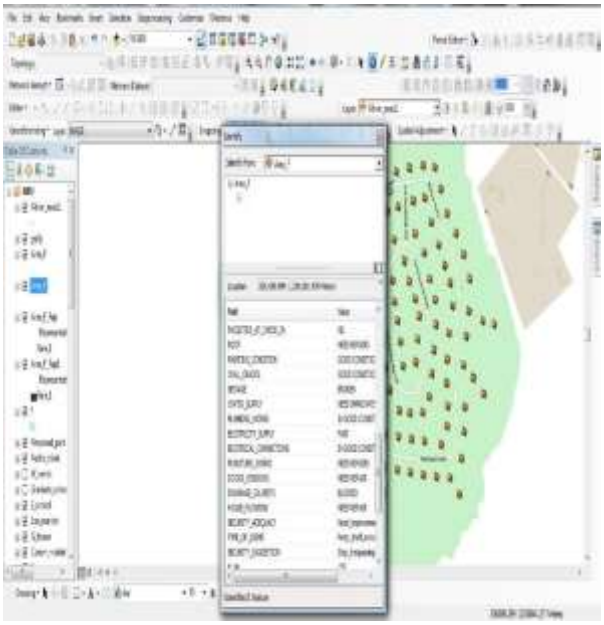

Fig. 3: The Estate
Source: Author's Analysis 2018

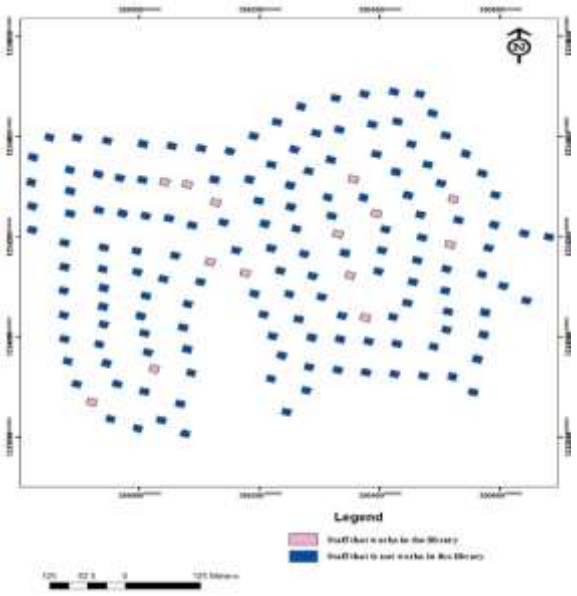

Fig. 4: The Staff that Works in Vice-Chancellor Office
Source: Author's Analysis 2018

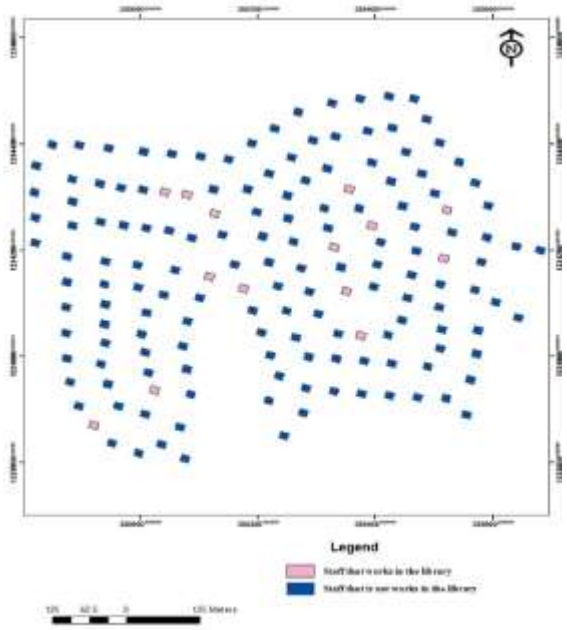

Fig. 5: The Staff that Works in Library
Source: Author's Analysis 2018

The results in Figure 3 show how a certain infrastructure and facility can be identified. Once the identifier tool is clicked on the infrastructure, the entire information on that object will be identified. About 8.75 % of the staff located in the study area work in library and in VC'S office while 91.25 % work in other sector of the university as shown on Figure 4 and 5 respectively. This result give information on area F housing units and this will give the decision makers prior clues on how to manage the infrastructure and facility. It will help the decision makers to easily and quickly identify housing infrastructures and facility and their attributes, including their information and identification of exact location of underground facilities (Weiss, 2009).

CONCLUSION

Conclusively, it was generally found that one third of the housing units were in bad conditions and not properly manage and as the results there is need for proper management of the infrastructure and facility in which this research gives the basis on how to be carryout with the aid of geospatial techniques. This research contributed in identifying the major problems with the

analogues way of infrastructural and facility management and provides a better way of solving these problems by developing the GIS-based infrastructure and facility management with linked all of the spatial and non-spatial information. Also, the research serves as a decision making tool and geospatial-interface for the Ahmadu Belllo University Zaria and information managers as the global level as the case may be. GIS has proven to be successful tools for educational institutions to effectively manage diverse housing units concerns and improve its management sustainability.

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