Design and Implementation of a Cadastral Information System and Assessment of the Utilization of Facilities in Nasarawa State University, Keffi, Nigeria

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Abstract
Cadastral Information System (CIS) is an organized system that records land information which describes spatial and non-spatial entities. The study was, therefore, aimed at designing and implementing a CIS as well as examine the utilization of facilities in the Nasarawa State University, Keffi (NSUK) using Geographic Information System GIS techniques. The objectives of the study were to: design and update the digital map of the institution, design and implement a CIS and analyze the efficiency of the database, and assess the utilization of the facilities in the the institution. The spatial data used are coordinates and attribute information of facilities obtained from the field using Garmin GPS, existing plan and topographic map obtained from the university planning unit, and high resolution satellite image covering NSUK extracted from Google Earth Pro platform. Information on the utilization of facilities in NSUK were collated from the administered questionnaire and direct field reconnaissance survey. Purposive sampling technique was used to sample 50 respondents on facility utilization in the institution (targeting lecturers and students). SPSS software was used to analyze the questionnaire. The local coordinates obtained from the field were transformed using the Universal Traverse Mercator (UTM) coordinate system and then used to plot the digital Map in ArcGIS 10.5 software. The database design was done in phases which include the conceptual design, the logical design, the physical design, and the implementation phase. The attribute data were linked with the spatial data to build the digital CIS and selected queries were performed using Structured Query Language (SQL) to test the efficacy of the implemented CIS database. The study established the capability of CIS in handling spatial and non-spatial data and result reveals that availability of facilities were insufficient, hence; not satisfactory. Evidence of new structures are noticed in the institution. The study recommends that a digital e-learning be sustained and CIS be adopted for proper property inventory, updating and general facilities development and management in NSUK.

Keywords: Cadastral Information System (CIS), GIS, Facility Mapping, LIS, NSUK, SQL

1. Introduction

Land Information System (LIS) is a geographic information system for cadastral and land use mapping and planning (Wade and Sommer, 2020). LIS refers to all land-related data banks that have the land parcel as the common geographic unit, and that by means of coordination and standardization, together, provide an integrated methodology for the collection and maintenance of land registry (Quintero, 2004). Most human activities and developmental efforts are based on land (Akingbade, 2012). Therefore, a systematic record of land and rights in land are vital for public administration, planning, development and private transactions in land and related cadastral matters (Melkamu, *et al*., 2020). A systematic record and rational use of the land should be of prime importance to planners and policy makers. Accurate and efficient land data inventory or records are a necessary tool for appropriate resources management and tackling of environmental problems (Mikir, 2019).

Cadastral Information System (CIS) in land management provides detailed information on real property within a specific area (Sonjay and Debashish 2016). Thus, Cadastral is the collection of all information which relates to individual land parcel which involves the physical delineation of property boundaries and determination of dimensions, areas and certain rights associated with properties: whether they are on land, water or defined by natural or artificial features (Akingbade, 2012). Although, in the majority of cases, the main component of a cadastral survey is the survey of the boundaries (footprints) of all the individual land parcels (Williamson, 2002).

More than two thirds of the worlds' lands are characterized by very poor titling systems (De Soto, 2016). According to Abhilash, Mohammed and Vijaya (2019), not more than 2.5% of the land in Nigeria has been registered since formal land registration and cadastral mapping began in 1863. Only few urban areas are covered. Even in the few urban areas, records are kept in manual and analogue form with no detailed information. Yet, basic maps needed for judicious resource planning, development, and management are lacking (Uluocha, 2012). The Nasarawa State University, Keffi (NSUK) has a well planned layout in analogue format. With the establishment of the Nasarawa Geographic Information Services (NAGIS), general digitization and automation of land registration has improved tremendously in the state. The need to automate land record keeping and facility management in NSUK has become inevitable in-view of the need to have a faster approach in land and facilities management in the campus. This is in line with the study carried out by Bello and Ikhuoria (2015) in the mapping and assessment of facilities in the University of Benin for efficient and effective spatial planning, service delivery, facilities management (FM) and landuse decision making aimed at achieving spatial justice and rapid development of available land resources.

In order to actualize the gap in the management of landed properties and facilities in NSUK, this study, therefore, considered Geographic Information System (GIS) approach to design and implement a digital Cadastral Information System (CIS) of the Nasarawa State University, Keffi (Keffi) Campus to serve as a template for other institutions of learning in Nasarawa State, the country and elsewhere. Geographic Information System (GIS) is a digital system for geographic data gathering, database storage and retrieval, manipulation, spatial analysis to find pattern, and

cartographic visualization of result in map and accompanying databases (Bello and Ikhuoria, 2015). The high accuracy, efficacy and swiftness of GIS to handle land information System (LIS) matters justifies its adoption in this study. In addition, GIS is very robust and its use in keeping facilities inventory, mapping and database management makes it a fit-for-all digital approach in effective and efficient land management (Akingbade, 2012).

2. Materials and Method

2.1 Study Area

The Nasarawa State Univeristy, Keffi (NSUK) campus is located in Keffi town in Nasarawa State, North Central Nigeria (Adama and Olalekan 2011) (Figure 1). Keffi lies approximately between latitudes 8^0 51' and 8^0 45' North of the equator, and longitudes 07^0 45' and 8^0 00' East of the Greenwich Meridian. The town is located just west of a junction of local roads that give it access to Abuja, Nasarawa, the Trunk "A" highway at Akwanga, and the main railway at Lafia. As at today, the total enrollment of students is put at 29,041 with 8 faculties.

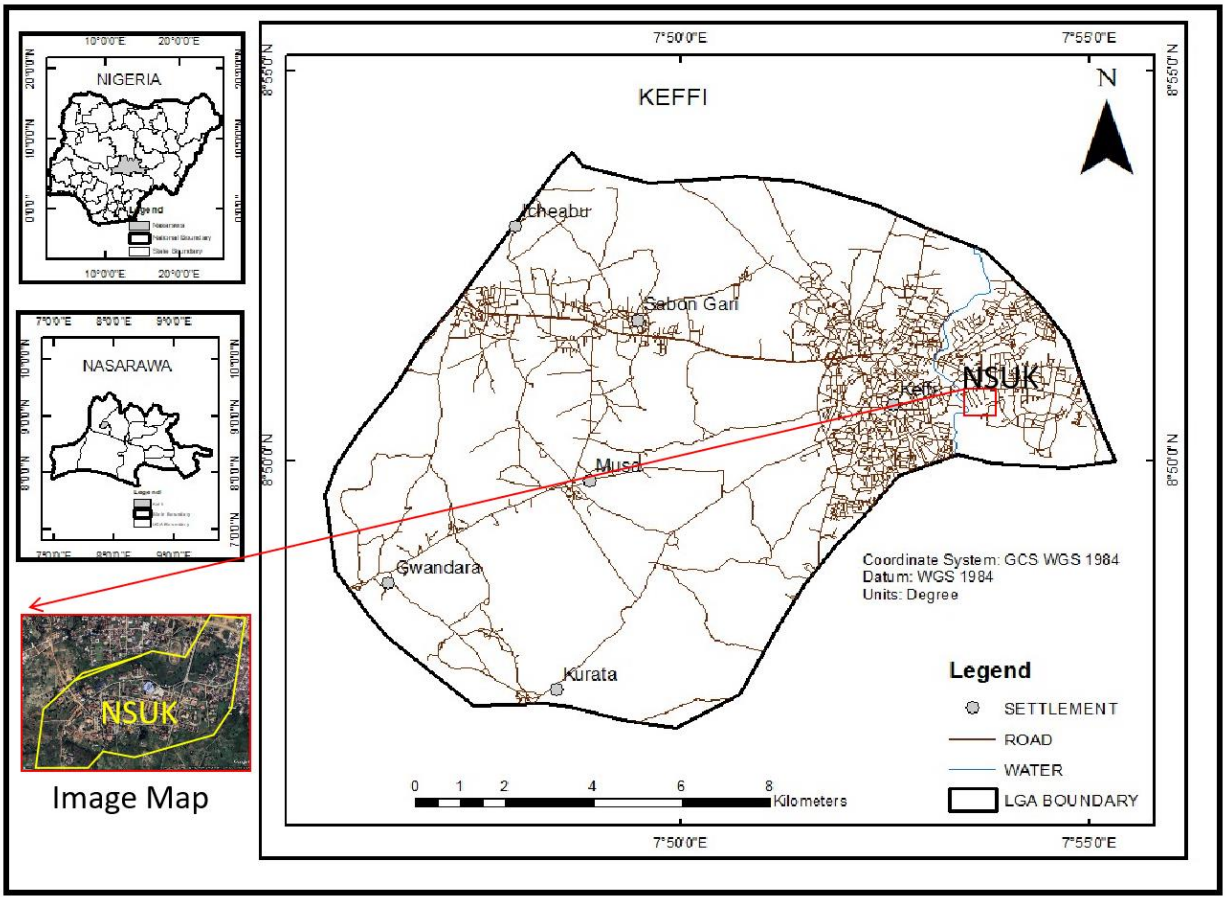


Figure 1: Location of NSUK in Keffi Local Government Area, Nasarawa State, Nigeria

The climatic condition in Keffi is influenced by two air masses. The south-westerly air mass is a rain – bearing wind that brings about rainfall from the months of March to October. The dry north-easterly air mass blows over the region from November to April, thereby bringing about seasonal drought. The mean annual rainfall in Keffi is about 1,400mm (Akwa, *et al.*, 2016). Keffi town is within the Keffi Local Government Area which generally has a temperature range of 36^0C – 39^0C (maximum) and 21^0C - 25^0C (minimum). The terrain is gently undulating with very gentle slopes and few drainage systems (streams) like Attai. The location of the NSUK over the years has attracted diverse people of different tribes, background, culture and traditions which have invariably influenced the building patterns and land development initiatives in Keffi. Thus, the need to have a well-structured database management system for facility inventory, mapping and management for the university has further reiterate the usefulness of Geographic Information Systems (GIS) for property/facility management in tertiary education landuse planning (Bello and Ikhuoria, 2015).

2.2 Methodology

Layout plan of the study area containing surveyed parcel boundaries, corners and monument was scanned and converted into a raster format. Further, a Garmin GPS receiver device was used to obtain the Ground Control Points - GCPs (coordinates) which were used to geo-reference the scanned layout plan as well as the high resolution image extracted from Google Earth Pro. On-screen digitizing was carried out in ArcGIS 10.5 environment to extract digital layers such as buildings, undeveloped land, reservoir, electric poles, cables, and other land uses.

New infrastructure and facilities not in the old plan were updated from the satellite image and then used to create a digital relational database and updating of facilities from where a Cadastral Information System (CIS) designed and was implemented.

Furthermore, on facility utilization, the population of the study incorporated staff and students of the Institution. Therefore, respondents were drawn randomly. Purposive sampling method was used to target only lecturers and students in the school, where 50 respondents (four each from the faculties and the administrative units) were selected to provide relevant information on the status of facilities and their utilization in Nasarawa State University, Keffi main campus. Data analytical technique used to check the efficiency and efficacy of the designed and implemented database of cadastral information system is the Structured Query Language (SQL) syntax: thus: *"Select*, From: Where".* Also, statistical techniques such as frequency distribution and simple percentages were used to analyze the data collected from questionnaire.

3. Results and Discussion

3.1 Updating Facility Map of NSUK

Figure 2 (existing plan of NSUK) and 3 (extracted satellite image of NSUK) as geo-referenced, rectified and updated with additional attribute information are shown. This process was done by importing both the scanned map and the high resolution satellite image covering the area into ArcMap GIS environment. The study shows that the four (4) control points picked helped to

geometrically reposition the spatial alignment of facilities as overlayed on the existing Facility Map of NSUK (Figure 2). Figure 3 shows the recent status of facilities (built infrastructure) in the campus from where the new Cadastral information system (CIS) of the campus is designed and implemented.

3.2 Cadastral Information System Map Layers of NSUK

Figure 4 to 9 shows the generated map layers for implementing the Cadastral Information System for the Nasarawa State University, Keffi (NSUK). These layers includes building footprint, road, stream, reservoir (overhead water tank). Layers such as electrical facilities like the poles, lines - both of low and high tension and transformers, power house, and other structures that were not on the scanned map needed for CIS preparation digitized and extracted from the satellite image of the area are shown (figure 3). Results of the CIS data layers are presented in figures 4 to 9. Each of the map shows a layer that makes up the CIS relational geo-database.

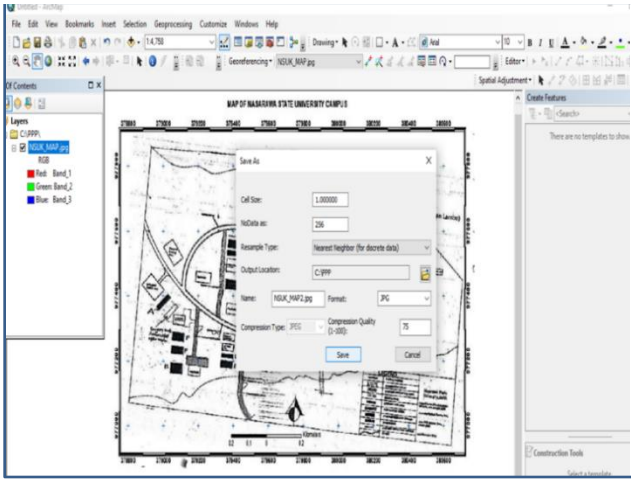


Figure: 2: Geo-referenced and Updating of NSUK Facility Map

Figure: 3: Geo-referenced Satellite Image covering NSUK showing landcover

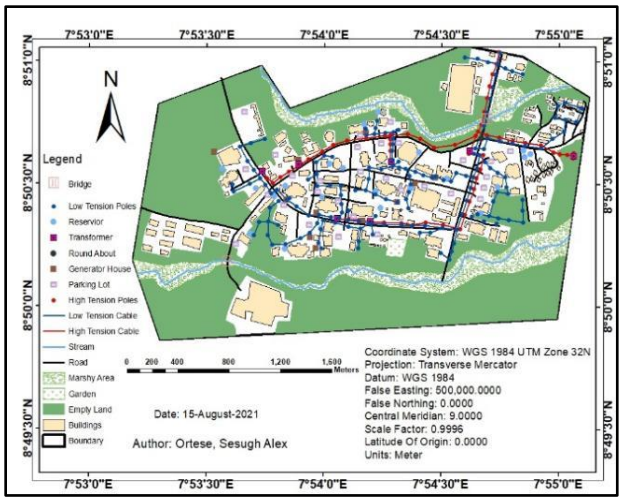


Figure 4: Digital Map of NSUK

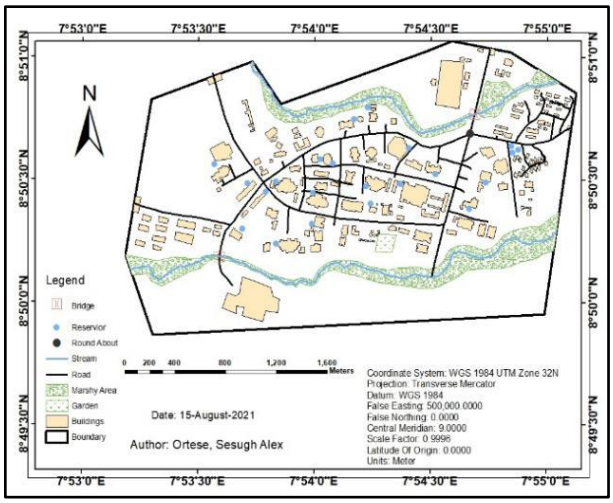


Figure 5: Building Facilities in NSUK

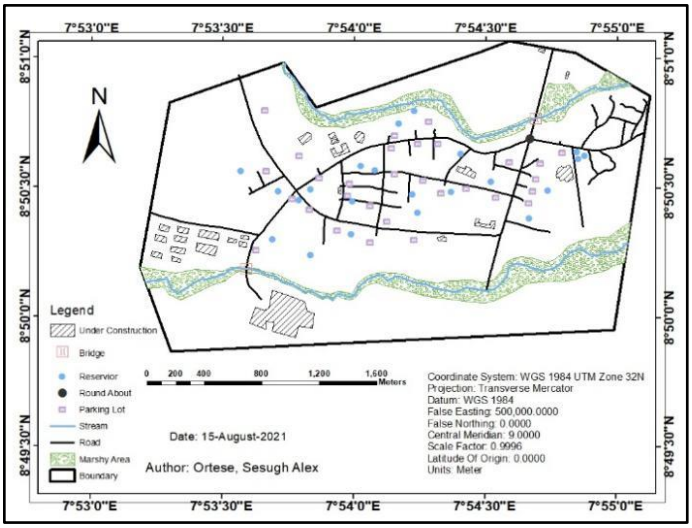


Figure 6: Buildings Under Construction

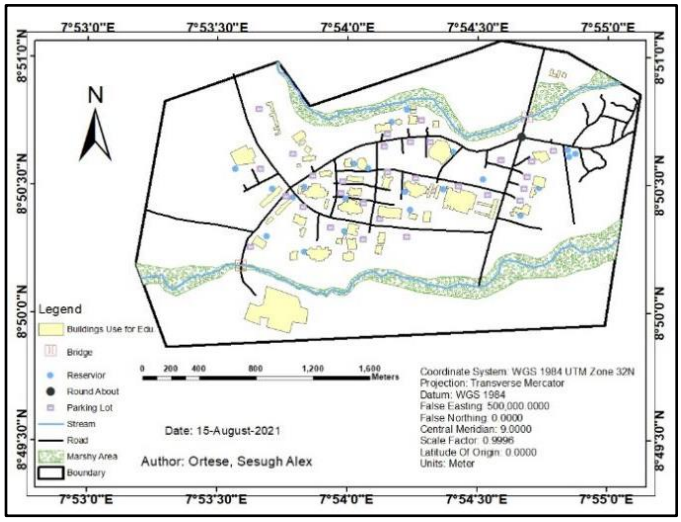


Figure 7: Buildings for Educational Use

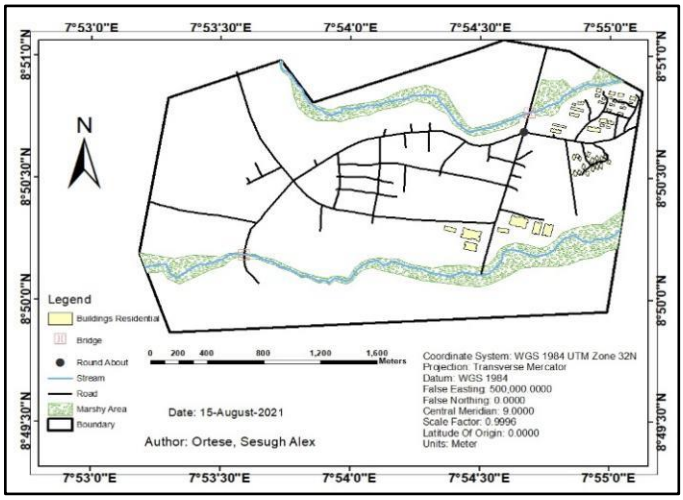


Figure 8: Buildings for Residential Use

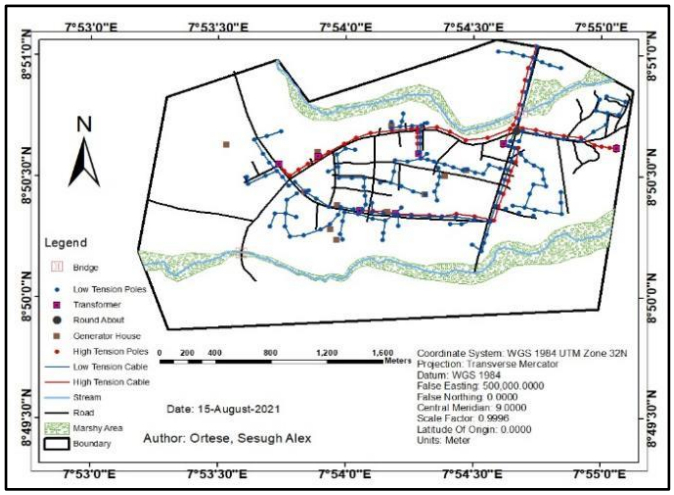


Figure 9: Electricity Facilities in NSUK

In specific terms, figure 4 shows the digital map produced based on UTM coordinate transformation on which the database was built. More so, figure 5 shows all the buildings in the study area; figure 6 shows buildings under construction; figure 7 presents buildings for educational use, and figure 8 shows buildings used for residential purpose, while figure 9 shows electricity facilities.

3.3 Efficiency of the Designed Database of Nasarawa State University, Keffi (NSUK)

The efficiency and efficacy of designed database for UNSUK is based on the second objective of the study. It is a powerful way of selecting what is needed. The following were queries generated.

Query 1: Query to shows all buildings and their attributes. See figure 9
Syntax :(selects all)

Query 2: Query by "building use"
Syntax: ("building"="Edu").
The above queries select buildings for educational use: See figure 10

Query 3: Query by "building use"
Syntax: ("building"="Residential")
The above queries select buildings use for residential. See figure 11

Query 4: Query by "Transformer name"
Syntax: ("name"="transformer")
The above query selects all the transformers. See figure 12

Query 5: Query by "type of Pole"= 'Concrete'
Syntax: ('type of pole'= 'Concrete')
The above query selects concrete poles. See figure 13

Tables 1 present buildings attributes data from the database which have been normalized upon which most of the above stated queries were performed, while table 2 and 3 present information on electricity facility respectively.

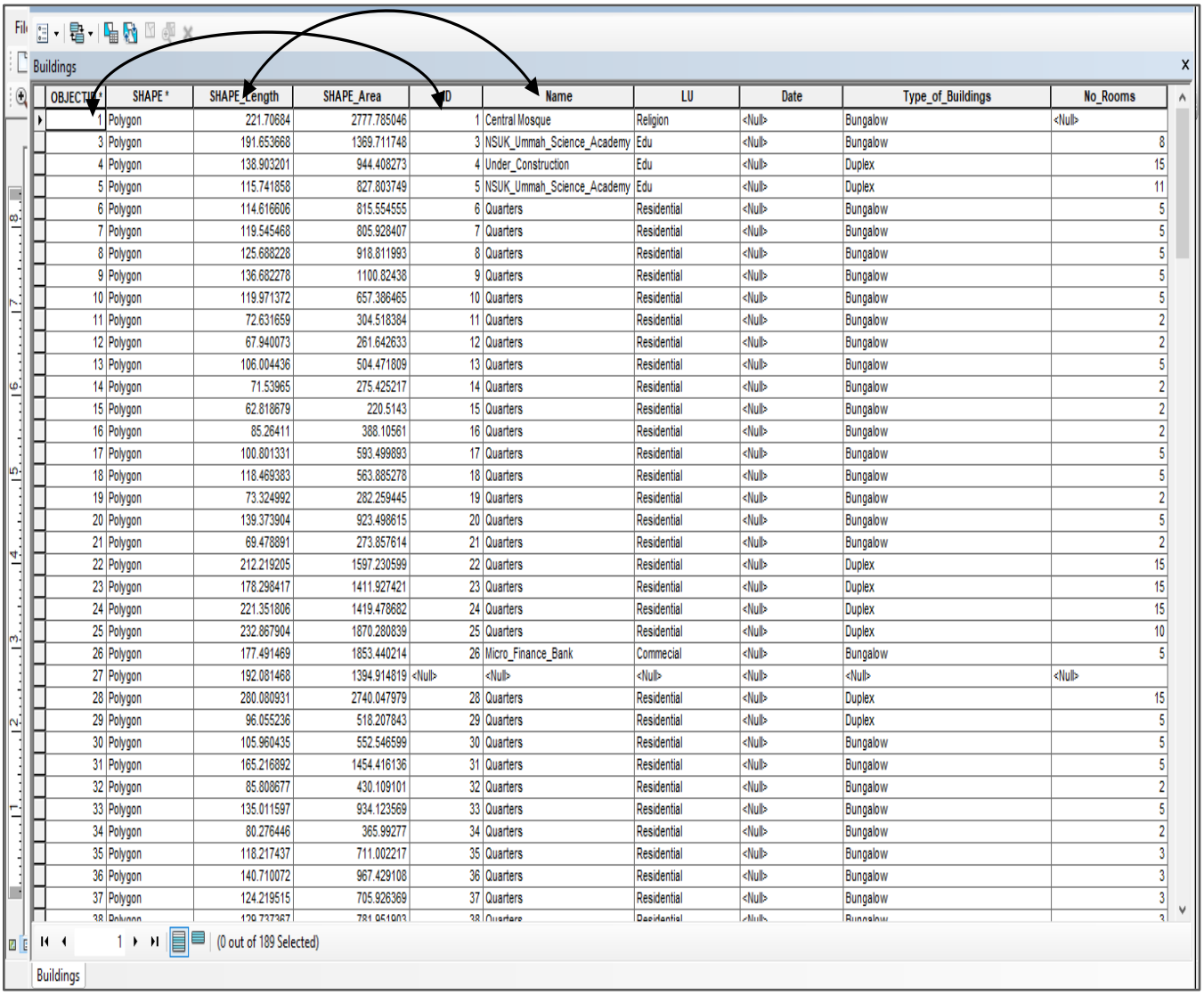
Table 2 and 3 presents attribute information of low and high tension electrical poles in the study area. The query generated using Tables 2 and 3 shows the following corresponding results in figures.

Figure 10 shows result of attribute Query of all the Buildings in the campus, figure 11 and 12 show the results of a query by attribute of buildings for educational and residential uses respectively, highlighted in light blue. Educational facility uses include lecture halls, laboratories, libraries and offices. Residential purpose are quarters for housing the university staffs and hostel for students' accommodation.

Figures 13, 14 and 15 show query results by attribute of transformers, low tension and high tension electric poles respectively.

Thus, the result of the query shows that seven (7) transformers are located to help redistribute electric energy in the campus.

Table 1: Building Attribute in the Cadastral Information System Developed for NSUK



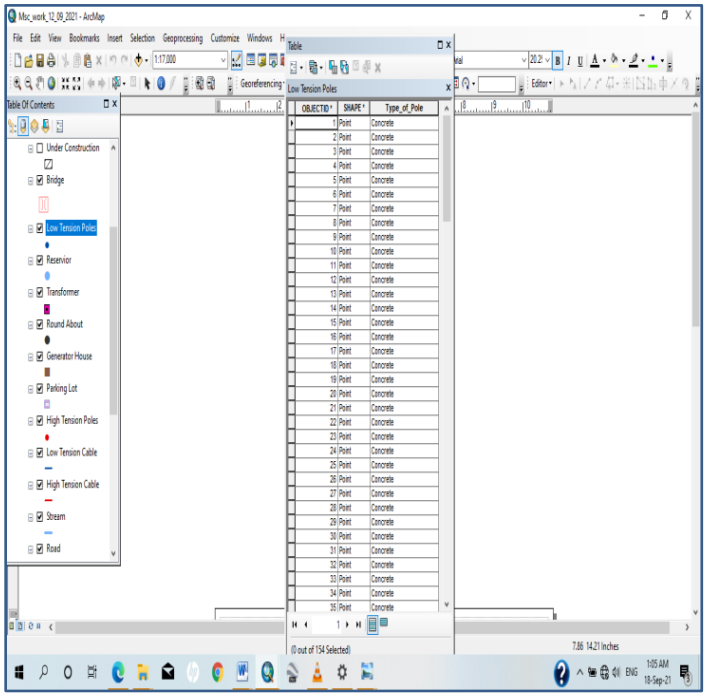
Buildings

OBJECTID *	SHAPE *	SHAPE_Length	SHAPE_Area	ID	Name	LU	Date	Type_of_Buildings	No_Rooms
1	Polygon	221.70684	2777.785046	1	Central Mosque	Religion	<Null>	Bungalow	<Null>
3	Polygon	191.653668	1369.711748	3	NSUK_Ummah_Science_Academy	Edu	<Null>	Bungalow	8
4	Polygon	138.903201	944.408273	4	Under_Construction	Edu	<Null>	Duplex	15
5	Polygon	115.741858	827.803749	5	NSUK_Ummah_Science_Academy	Edu	<Null>	Duplex	11
6	Polygon	114.616606	815.554555	6	Quarters	Residential	<Null>	Bungalow	5
7	Polygon	119.545468	805.928407	7	Quarters	Residential	<Null>	Bungalow	5
8	Polygon	125.688228	918.811993	8	Quarters	Residential	<Null>	Bungalow	5
9	Polygon	136.682278	1100.82438	9	Quarters	Residential	<Null>	Bungalow	5
10	Polygon	119.971372	657.386465	10	Quarters	Residential	<Null>	Bungalow	5
11	Polygon	72.631659	304.518384	11	Quarters	Residential	<Null>	Bungalow	2
12	Polygon	67.940073	261.642633	12	Quarters	Residential	<Null>	Bungalow	2
13	Polygon	106.004436	504.471809	13	Quarters	Residential	<Null>	Bungalow	5
14	Polygon	71.53965	275.425217	14	Quarters	Residential	<Null>	Bungalow	2
15	Polygon	62.818679	220.5143	15	Quarters	Residential	<Null>	Bungalow	2
16	Polygon	85.26411	388.10561	16	Quarters	Residential	<Null>	Bungalow	2
17	Polygon	100.801331	593.499893	17	Quarters	Residential	<Null>	Bungalow	5
18	Polygon	118.469383	563.885278	18	Quarters	Residential	<Null>	Bungalow	5
19	Polygon	73.324992	282.259445	19	Quarters	Residential	<Null>	Bungalow	2
20	Polygon	139.373904	923.498615	20	Quarters	Residential	<Null>	Bungalow	5
21	Polygon	69.478891	273.857614	21	Quarters	Residential	<Null>	Bungalow	2
22	Polygon	212.219205	1597.230599	22	Quarters	Residential	<Null>	Duplex	15
23	Polygon	178.298417	1411.927421	23	Quarters	Residential	<Null>	Duplex	15
24	Polygon	221.351806	1419.478682	24	Quarters	Residential	<Null>	Duplex	15
25	Polygon	232.867904	1870.280839	25	Quarters	Residential	<Null>	Duplex	10
26	Polygon	177.491469	1853.440214	26	Micro_Finance_Bank	Commecial	<Null>	Bungalow	5
27	Polygon	192.081468	1394.914819	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>
28	Polygon	280.080931	2740.047979	28	Quarters	Residential	<Null>	Duplex	15
29	Polygon	96.055236	518.207843	29	Quarters	Residential	<Null>	Duplex	5
30	Polygon	105.960435	552.546599	30	Quarters	Residential	<Null>	Bungalow	5
31	Polygon	165.216892	1454.416136	31	Quarters	Residential	<Null>	Bungalow	5
32	Polygon	85.808677	430.109101	32	Quarters	Residential	<Null>	Bungalow	2
33	Polygon	135.011597	934.123569	33	Quarters	Residential	<Null>	Bungalow	5
34	Polygon	80.276446	365.99277	34	Quarters	Residential	<Null>	Bungalow	2
35	Polygon	118.217437	711.002217	35	Quarters	Residential	<Null>	Bungalow	3
36	Polygon	140.710072	967.429108	36	Quarters	Residential	<Null>	Bungalow	3
37	Polygon	124.219515	705.926369	37	Quarters	Residential	<Null>	Bungalow	3

(0 out of 189 Selected)

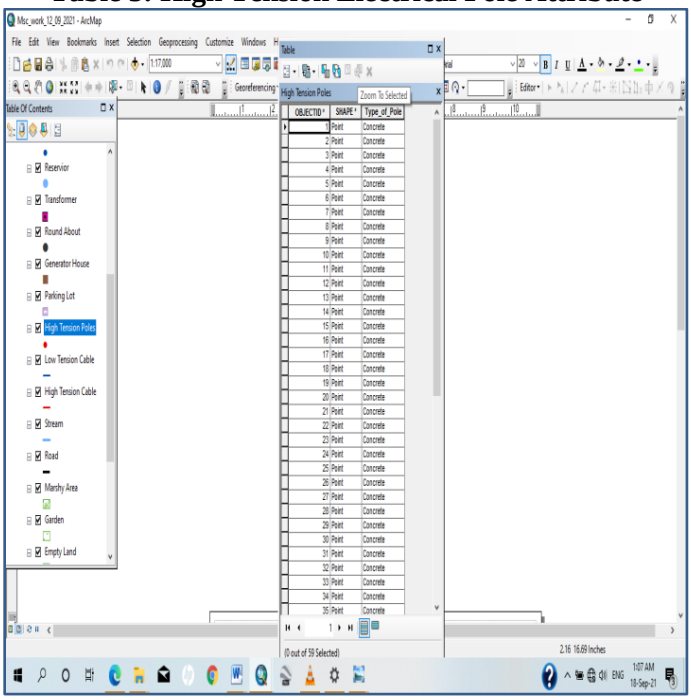
Source: Field Survey (2022/23)

Table 2: Low Electrical Tension Pole Attribute



Source: Field Survey (2022/23)

Table 3: High Tension Electrical Pole Attribute



Source: Field Survey (2022/23)

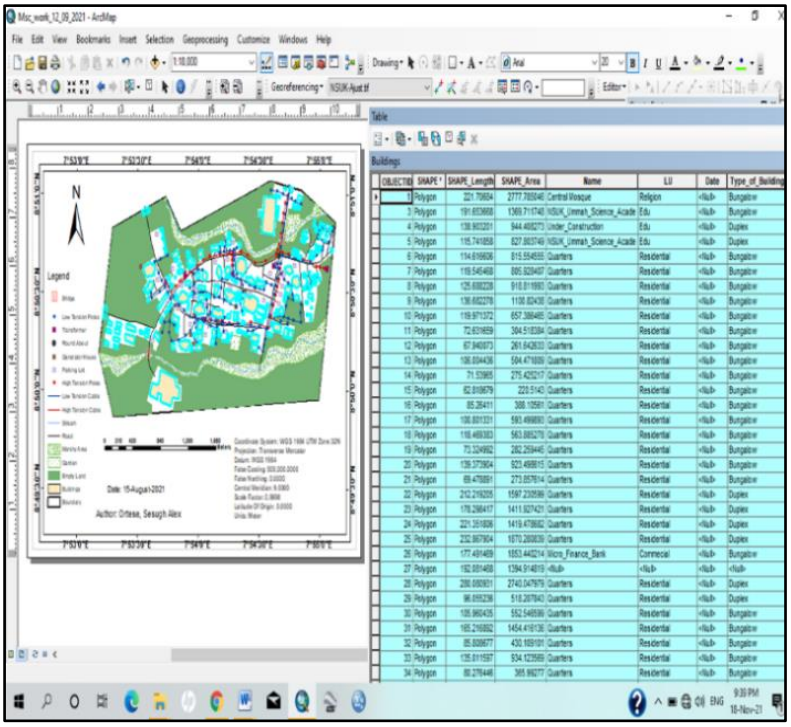


Figure 10: Attribute Query of all the Buildings in NSUK

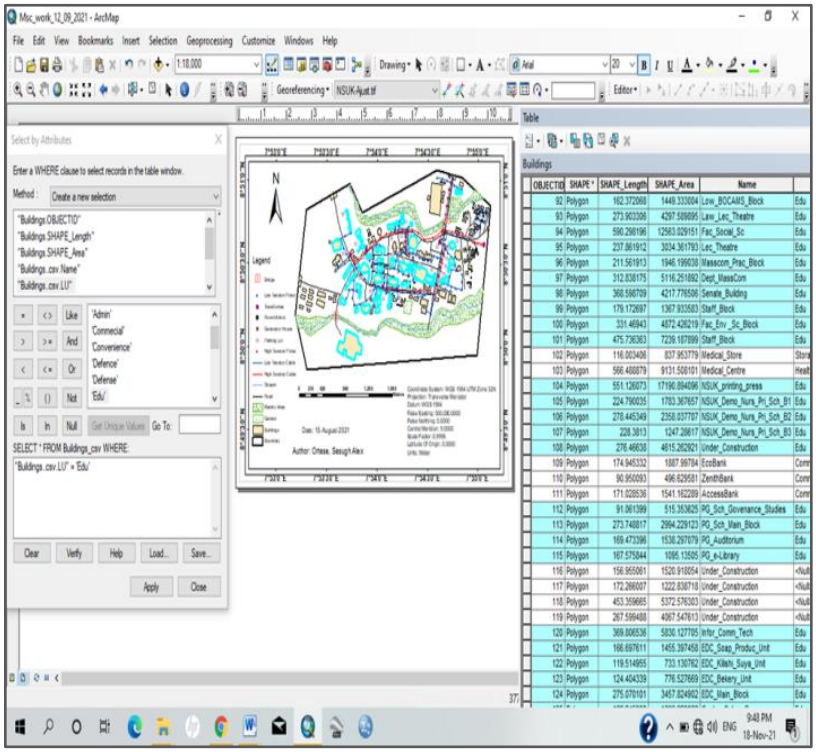


Figure 11: Spatial/Attribute Query of Educational (teaching) buildings

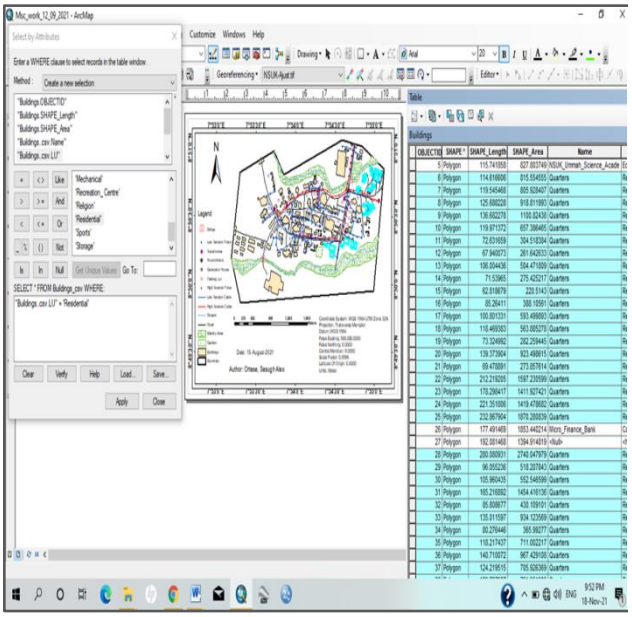


Figure 12: Spatial and Attribute Query of Residential Buildings in NSUK

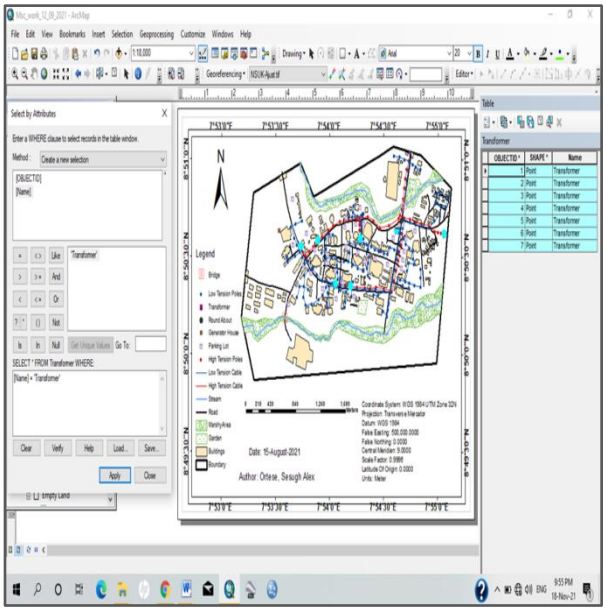


Figure 13: Spatial and Attribute Query of Transformer Distribution in NSUK

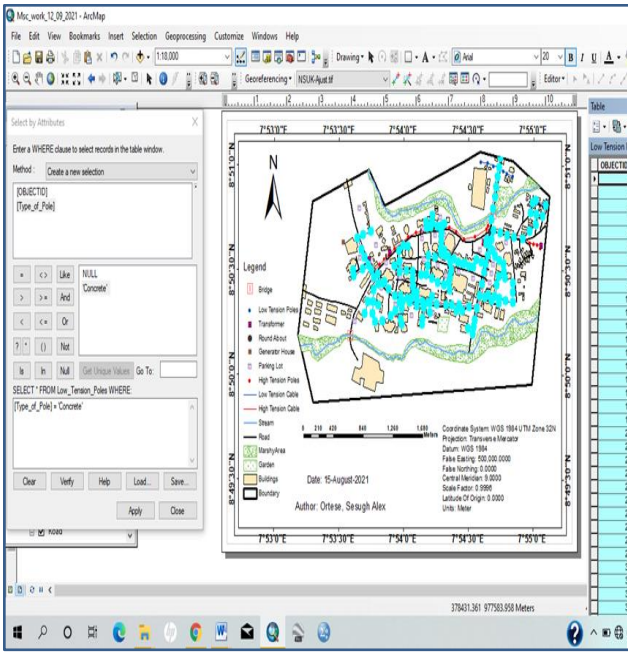


Figure 14: Spatial and Attribute Query of Low Tension Electrical Poles

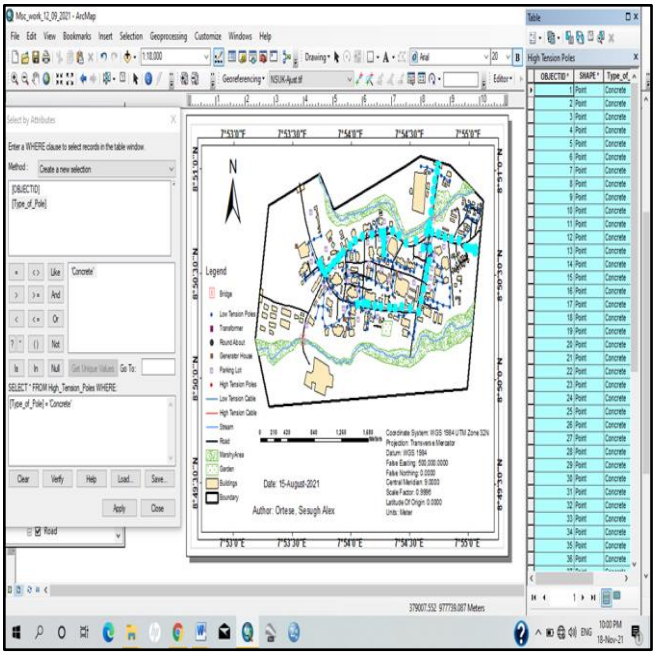


Figure 15: Spatial and Attribute Query of High Tension Electrical Poles

3.4 Assessment of the Utilization of Facilities in NSUK

On facility utilization in the study area, results from the analysis are tabulated in Tables 4 to 12 sequentially. In specific, Table 4 shows information on respondents occupation, Table 5 shows respondent responses on sharing of office with other staffs while Tables 6, 7, 8, 9, 10, 11, 12 provides information on offices attached with toilet, types of toilet, number of lecture theaters/seats enough to contain students per lecture, reasons for the shortage of lecture rooms/seats, access to toilet any time pressed for personal comfort, condition of the toilets, and water sources in the NSUK main Campus in Keffi. Table 13 shows respondents' responses on the rate of water supply in the study area, while Table 14 contains responses on the question of facility (ies) supposed to be made available but are not readily available in quality and quantity. All information collated and examined forms the bases for assessing the utilization of facilities in the campus. The results obtained provided ideas of what is available and what needs to be done to improve on to make learning more conducive for both lecturers and students alike in the university (NSUK).

In specific terms, Table 4 shows the distribution of respondents based on their occupation; in which 28% of the respondents are academic staff of the university, 28% are non-academic staff, and 28% of the respondents are students of same institution; while 16% of the respondents falls to other categories of occupation. Table 5 shows that 64% of the respondents disagreed by answering 'No' that they share office with other Staffs while 36% agreed by saying 'Yes' which mean they share office with other staffs. Table 6 revealed that 68% of the respondents disagreed by answering 'No' while 32 % agreed by saying 'Yes' that their offices are attached with toilet. On the types of toilet facility, Table 7 revealed that 62% of the respondents use toilet facility that are water system-based, while 38% of them use toilets facility that are manually operated where one has to source for water before use. On the distribution of lecture rooms/seats, Table 8 revealed 72% of the respondents said "No" while 28% of the respondents answered "Yes", This result indicates that the number of lecture rooms/seats are inadequate for students' lectures; hence the need to build more in view of the increasing number of students' intake into the institution. This is important as NSUk is seen as one of the most sought-after university in North Central Nigeria due to her consistency in academic session and high level of academics activities and research outputs every session. The high level of academic activities especially with the Postgraduate students is also very high with many prospective students choosing NSUK as the university of best choice mainly due to its proximity to Abuja, Nigeria's Federal Capital.

Table 4: Respondents' Occupation

Attributes	Frequency	Percentage (%)
Academic staff	14	28
Non-Academic staff	14	28
Student	14	28
Others	8	16
Total	**50**	**100**

Table 5: Sharing of Office with Other Staffs

Attributes	Frequency	Percentage (%)
Yes	18	36
No	32	64
Total	50	100

Table 6: Offices Attached With Toilet

Attributes	Frequency	Percentage (%)
Yes	16	32
No	34	68
Total	**50**	**100**

Table 7: Type of Toilet

Attributes	Frequency	Percentage (%)
Water system	16	32
Manual flushing	34	68
Total	**50**	**100**

Source: Field Survey 2022/23

The findings in this study indicate that, as the number of school enrollee increases, there is the need to have a corresponding space and facilities to accommodate and manage them. As observed from the physical facilities and structures in NSUK, a number of improved structures in terms of teaching aids and facilities are on the increase. New centers of excellence and institutes specialized studies are also coming up to cater for the academic needs of prospective students. If this trend is sustained, the supposed learning environment that is conducive for scholarship will be fully achieved. In particular, Ted-fund buildings are noticeable in NSUK and such interventions should continue in order to meet the increasing demand for scholarship.

Table 9 shows information on the factors responsible for observed shortage in the distribution of lecture rooms/seats in NSUK. 50% of the respondents noted that the factors responsible for the shortage of lecture rooms/seats is due mainly to damages of existing facilities without corresponding repairs and/or acquisition of new ones, 32% opined that insufficient provision for these facilities, as well as over admission (18%) of excess students beyond the carrying capacities of existing facilities are largely responsible for the observed current shortages of lectures rooms and seats in NSUK. This is understandable as NSUK have to merge two sessions in order to accommodate the excess due to the about eight (8) months strike by the Academic Staff Union of Universities (ASUU) experienced in year 2022. The management of NSUK in her wisdom have no choice but to ensure that qualified candidates are given admissions and catered for as lectures

are, in most cases, held in large lecture halls while those in 100 and 200 levels mostly take their lectures online via the e-learning platforms provided by the institution. The digital e-learning initiative confirms the adage that "necessity is the mother of invention". The e-learning strategy in managing the delivery of lectures is a right step in the right direction and, as such, it should be sustained by the management of NSUK as obtains in both developed and developing countries where e-learning platforms are used to deliver lectures and monitor progress of student in terms of assignments and other learning activities. This corresponds with the findings of Macharia and Nyakwende (2010) and Rosenberg (2001).

Furthermore, Table 10 further revealed that 76% of the respondents agreed by answering 'Yes' that they have access to toilet any time pressed and want to ease self, while 24 % disagreed by saying 'No' - confirming that they don't have any access. This is understandable in view of the fact that only main staff offices have toilet facilities while the rest are mostly converted rooms to offices without provisions earlier made to have toilet attached to them. Also, some of the offices have shared toilets facilities. Table 11 shows that 54% of the respondents indicate very poor condition of the toilet facilities, 26% poor condition, 18% of the respondents choose satisfactory, while 2% indicate excellent. Expectedly, the offices of the principal officers of the institution and those that resorted to self-help have to be in good shape and maintained to high degree of human comfort.

The study further reveals that there are dedicated staff that ensure the lectures halls and offices are cleaned every morning. Nevertheless, there is need for improvements in sanitation and functionalities of electrical fittings like light bulbs, sockets and switches.

Table 8: Number of Lecture Rooms/ Seats Enough to Contain Students per Lecture

Attributes	Frequency	Percentage (%)
Yes	14	28
No	36	72
Total	**50**	**100**

Table 9: Reasons for the Shortage of Lecture Rooms/ Seats

Attributes	Frequency	Percentage (%)
Insufficient provision	16	32
Got damage	25	50
Over admission of students	9	18
Others	0	0
Total	**50**	**100**

Table 10: Access to Toilet Any Time Pressed and Want To Ease Self

Attributes	Frequency	Percentage (%)
Yes	38	76
No	12	24
Total	**50**	**100**

Table 11: Condition of the toilets

Attributes	Frequency	Percentage (%)
Excellent	1	2
Satisfactory	9	18
Poor	13	26
Very poor	27	54
Total	**50**	**100**

After air, water is one of the most widely used natural resources by man, and the sources of water are diverse: from surface, rainfall and underground (bore hole) sources to ice melting. From the analysis carried out in this study, Table 12 reveals that 42% of the respondents indicate "tap" to be the major source of water. Tap is followed by 36% for borehole, while 22% indicated water tanker supply to be another source of water in the study area. The result implies that, at any time, there is no tap water or tanker to supply water; staff and students will have no choice than to go to the borehole to source water for their use.

Table 13 further shows that 48% of the respondents indicate low level of water supply, 34% choose medium, while 18% of the respondents choose high. This implies that the amount of water supply in NSUK is not meeting the demand; hence, the need to improve water supply in the campus. With respect to whether or not there are facilities that are supposed to be provided but not adequate or available, Table 14 revealed that 36% responded "No", and 24% stated "Yes". Thus, the remaining 40% of the respondents fall under the categories of "others" who neither answered "*yes"* nor *"no"*.

The findings above imply that, there are other facilities or certain services that are supposed to be in place in the campus but are not readily available for effective learning for students. For example, Internet providers like MTN, Glo, and Airtel are available but most of the respondents noted that the signals are very poor and they prefer that the school's authority make provisions for fast internet facilities; preferably, fibre optics in the campus to ease learning, especially with the advent of e-learning which facilitates and provides ease of self-studies.

Table 12: Water Sources in the Study Area

Attributes	Frequency	Percentage (%)
Borehole	18	36
Tanker Supply	11	22
Tap	21	42
Total	**50**	**100**

Table 13: Rating Water Supply in the Area

Rating	Frequency	Percentage (%)
High	9	18
Medium	17	34
Low	24	48
Total	**50**	**100**

Table 14: Any Facility supposed to be Made Available but are not

Attributes	Frequency	Percentage (%)
Yes	12	24
No	18	36
Others	20	40
Total	**50**	**100**

Source: Field Survey 2022/23

3.5 Discussion of Results

This study was aimed at designing and implementing a Cadastral Information System (CIS) and also examining the utilization of facilities in the Nasarawa State University, Keffi (NSUK) Campus. The study updated the layout plan (map) of NSUK by incorporating coordinate system (geo-referencing) of existing plan and extracting recent infrastructure from high resolution image covering the study area from Google Earth Pro. A Cadastral Information System (CIS) was developed. The result of the normalization of the database as shown in Table 1 presents how redundancy and inconsistency were eliminated to make the database more flexible for ease of spatial query (SQL). Also, the query operation results in Figures 10, 11, 12, 13, 14 and 15 demonstrate the efficacy and efficiency of GIS in handling cadastral information inventory and spatial management of the environment. The queries generated from the database shows clearly the advantages of digital cadastral information system over analogue in which queries cannot be performed on any layers. The study has established that GIS is central to producing an accurate digital cadastral map (plan) because it is able to handle large volumes of geometric dataset and corresponding attribute information. Massive and accurate decision making on land matters which is fundamental to spatial justice and economic development of any organization, if fully optimized

and improved upon with the development CIS, will improve service delivery and operational planning.

The study further reveals that there are many facilities which are considered basic in the study area, and these includes, viz: buildings, offices, class rooms/seats, toilets and water, among others. Toilets were rated 76% available by the studied group (respondents) though mostly in repairable conditions. Lecture rooms/seats are rated 72% insufficient attributing it to poor damages. Water supply was rated 48% which is very, very poor. This shows that the relevant authorities responsible for facility management in the citadel of learning need to focus more attention on facility repairs, water supply and sanitation which are necessary for the health of students and staff members. Results obtained further show that respondents are of the view that the available facilities are inadequate to meet the ever increasing student and staff population in the campus, and even with the available ones, in poor condition, there is the need for continuous maintenance. And knowing the "what" and "where" of each facility in the developed and implemented CIS for the NSUK has been made possible with the inventory and mapping of the infrastructures and facilities in the campus. Thus, this study is similar to the findings of Bello and Ikhuoria (2015), who in the study of the nature and spatial distribution and uses of educational facilities and land uses in the University of Benin noted that, among others, the capability of GIS technology in facility mapping and management of educational landuse. This is important for informed decision making by the authorities managing the educational facilities as well as the endless ability to effect Queries to obtain instant result for planning and sustained development.

4 Summary and Conclusion

The need to keep record and mapping of educational facilities and infrastructures have been well noted in literature. This is because, the information gathered are useful for informed decision making for the overall well-being of staff and students in the Nasarawa State University, Keffi (NSUK). Therefore, this study was able to achieve its primary goal, which was the design and implementation of a digital Cadastral database for the NSUK. The database created consist of building footprints and accompanying attributes like size and use; road network; electricity infrastructure (electric poles, transformer, building fittings, etc.); water sources and utilization; vehicle parking lot, toilet facilities, educational land uses, among others. The efficacy of GIS technique implemented as CIS tested through various analysis carried out shows the suitability of the model to solving various cadastral problems through SQL queries. More so, the developed CIS will enhance the physical planning of the citadel of learning as well as the use of GIS for effective landuse planning and management. Availability of physical facilities such as seats in lecture halls, offices, toilets and water supply were found to be unsatisfactory because they were considered inadequate and fall short in effective and efficient utilization by the users in the campus. Majority of the respondents were not satisfied with the condition of the available facilities as they complained of insufficient provisions in quantity and quality. This is very evident in the lights and chairs in some lecture halls. The study further shows that there is a consensus and clamour for the provision of more of the facilities for ease of access and effective functioning of the citadel of learning. The study also reveals that there is increase in student and staff population to cater for the need for higher tertiary learning as the institution has gradually be on the top list for prospective

students seeking higher education both at graduate and undergraduate levels. Also, there are a number of new infrastructures coming up and many have been completed for use. These new educational facilities are aimed at ameliorating or mitigating the perceived fears in insufficient facilities in the university.

Having known what it takes to respond to the changing world of information technology through e-learning, and also having gone through the design, creation and implementation of a digital database for cadastral records, the following recommendations are made to improve learning in the great citadel of learning;

i. A GIS-based Cadastral Information System (CIS) should be set up to adequately manage facilities in NSUK.
ii. Database should be created for all cadastral works in NSUK and, by extension, all universities in Nigeria by relevant authorities in the schools and Ministry of Education.
iii. There should be more provision of digital surveying and mapping equipments that will considerably commensurate with the needs of the students studying Geospatial courses like GIS, Remote Sensing, Surveying, Architecture, among others.
iv. Students should be exposed to other areas of GIS applications outside surveying and Cartography with focus on facility and land (property) management.
v. Adequate provision of logistics for students during research work pertaining to geospatial mapping and studies should be intensified.
vi. There is need to provide more and better sanitation and facilities in NSUK. For instance, more lecture halls, Internet, water and lighting facilities should be provided in quantity and quality to help facilitate learning by students and teaching by lecturers.

Conflict of Interest:

The authors declares that there is no conflict of interest in this study as it is primarily empirical in nature and a proof of concept of CIS in Educational Landuse and Facilities Management.

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