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A Geosolution for Campusfacility Planning and Management System (Cafpams): Prototyping the D S Adegbenro ICT Polytechnic Community

[1]Ademeno W. O, [1]Majekodunmi Oladapo Quadry, [2]Lawal O. O., [2]Oyefusi A. S.

[1]*(Department of Surveying &Geoinformatics)*
[2]*(Department of Computer Science)*
D. S. ADEGBENRO ICT Polytechnic, Itori-Ewekoro, Ogun State, Nigeria

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ABSTRACT
Planning and managing facility is a vital organic function of the city planners. Today, GIS is playing greatly assisting in solving problems and challenges confronting this sector. Several environmental and spatial community problems bother our contemporary society and, in the same vain, bother the campus. The problems range from the wrong planning of an academic campus to the location of facilities like the emergency vehicles and first aid materials. The compelling need to study how the environment can be adequately and correctly managing the environment and also identifying hazards cannot be over-emphasized, and thus the reason for the project.

The research work was carried out when the polytechnic had not erected much structures. It was embarked upon to show her present status at that time and also to take into cognizance, futuristic development that would span the entire campus which requires effective planning and management of the campus. Today, appreciable developmental structures had beenimplemented and some recommendations of these project had been taken into consideration such as road mapping, re-planting of trees, erecting of more lecture rooms and theatres for redistribution of population to ease the problem of over-concentration of the populace on some vital buildings. The polytechnic community now has a 1000-capacity auditorium; a modern library complex (still under construction); new management science complex, management science administrative building, SLT Extension block for lectures and expanded lecturer officesat both Engineering Complex and Science Laboratory Department.

This timely and important study has done something of immense contribution to development within the vicinity of the region of study. The study analysed the campus environment based on some considerations to enable relevant authorities come up with effective strategic planning and concrete decision that will make the community more effectively and efficiently utilised. The environmental assessment and analysis were carried out along four segments: the space management, the tree location management, the noise management, and the emergency planning and response management.

I. INTRODUCTION

Space management planning, emergency planning and response, transportation, infrastructure/ facility management, effective and accurate campus administration are concerns that should be carefully considered and managed to achieve a near perfect academic community.

Educational institutions—universities, colleges, schools, libraries, and other centers of learning—are physical entities. A real picture of a campus community typically reveals the learners, their learning providers, other supportive staff, traders, visitors and all other service providers are the occupants of a campus.A closer look will unveil the actual geography of the inhabitants, their experience and navigation e.g. the physical environment of campus buildings, and districts which are a blend of real properties, associated physical assets, and supporting infrastructure with notable spatial footprints, exterior and interior facets, multiple dimensions, and life cycles. Since they are"living" entities, campuses and educational districts grow and change and so, require meticulous planning, management, maintenance, and sustenance. Within and across all of these, geographic information system (GIS) technology and approaches play vital roles (Esri, 2012).

The "organized collection of computer hardware, software, geographic data and personnel design to efficiently capture, store, update, manipulate, analyse, and display all forms of geographically referenced information" is called Geographic Information System (ESRI, 1990). With its capabilities for business mapping, geospatial analysis and its contribution to decision making, GIS is a valuable tool applicable in campus environment analysis. GIS has been applied in many disciplines including geography, forestry, urban planning, and environmental studies. The role of GIS in environmental studies is immense and highly significant. GIS operates on two data elements, which are spatial and attribute data. Spatial data or geographic data refers to a known location on the earth surface which is defined by coordinates and the attribute by place names, address and post codes (Jovanic, 2008).

In the 21st century, GIS based Campus Information Systems (CIS) have been used by many educational institutions for different aims and become an effective tool. CIS is a wholeness and integrity that is formed by hardware, software, data and users in order to collect spatial and non-spatial data about the campus and its sub-units, both academic and administrative. These data are then, transfer to computer, store, query, analyse and present the result reports as graphics or non-graphics **(**Çiğdem TARHAN et al, 2006).

Beit known that, GIS has become a widespread application in diverse disciplines such as urban and regional planning, cartography, tourism sector, local governments and private sector. Generally, GIS could be defined as a system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analysing and disseminating and presenting spatial and non-spatial information about areas of the earth (Chrisman, 2002).

The Campus facility planning and management system (CAFPAMS) is a typical CIS aimed at producing a system who are saddled with the task of planning and managing our tertiary institutions in Nigeria.

1.2Aims and Objectives

- To identify ambience suitable for lecturing and learning and to also delineate noise disturbance zone.
- To state the possible environmental impacts of some features.
- To show areas of risk that hold substantial number of potential victims for emergency materials deployment.
- To holistically view and analyse the level of development within the study area.

II. THE GEO-SOLUTION

The timely and necessary study has done something of immense importance to humans within the vicinity of the region of study. The study analysed the campus environment based on some considerations to enable relevant authorities come up with decisions and strategies that will make the community more effectively and efficiently utilised. The environmental assessment and analysis was carried out along four lines: the space management, the tree location management, the noise management, and the emergency planning and response management.

2.1SPACE MANAGEMENT SOLUTION

The space management has identified the limited use of the available land resource within the campus. This calls for proper attention to the land resource left untouched to increase the facilities and hence the capacity of the institution of learning so as to create education for the larger public.

2.2 TREE LOCATION MANAGEMENT SOLUTION

The tree location management has, with careful measurements and analysis, assessed trees not condemning their planting but the location of some along certain roads as specified in the discussion section.

2.3 NOISE MANAGEMENT SOLUTION

The noise management looked into the various sources of noise, determined the major cause of the menace, and delineate its variation pattern around its immediate surroundings. The noise study goes further to show the structures that falls within certain range of sound pressure in decibels.

The last and a very important aspect of the project is the emergency planning and response management.

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2.4 EMERGENCY RESPONSE MANAGEMENT SOLUTION

The emergency study on its part viewed the campus holistically and observed the likely spread of the population around the campus. This spread is then presented in a form that elicits the easiest of decisions when it comes to where should be the location of a potential rescue team or officer. This kind of project is a long term project which could be carried on by other people therefore cannot be completed at once.

III. RESEARCH METHODOLOGY

3.1 DATA ACQUISITION METHODS

Geographic data can be collected using ground, aerial survey and GPS/Satellite techniques. In this case, ground survey and GPS techniques were employed. Attribute data were collected by field investigation, site inspection and other observations.

3.2 HARDWARE/ SOFTWARE REQUIREMENT

HARDWARE: Equipment such as Total Station and Global Positioning System were employed. The data collected were processed using computer system.
SOFTWARE: MS WORD, EXCEL, ARCGIS 9.3.

3.3 Study Area

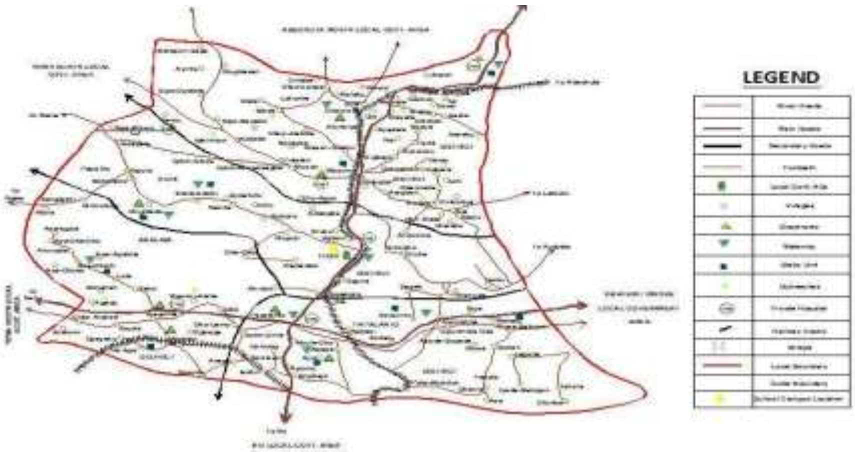

Figure 1: Study area within Ogun state, Nigeria

D.S Adegbenro ICT Polytechnic was founded in 2006. The campus was named after D.S Adegbenro, who was an elder statesman that served during Awolowo's administration. Located at about 40km from Lagos and 30km to Abeokuta, the school is within Ewekoro Local Government Area, Ogun State. Itori-Ewekoro, which houses the campus and depicted by the yellow symbol on Figure 1.3, has two traditional chiefs: Olu of Itori&Jagunna of Ijagunna and also remains home for the popular Lafarge cement company.

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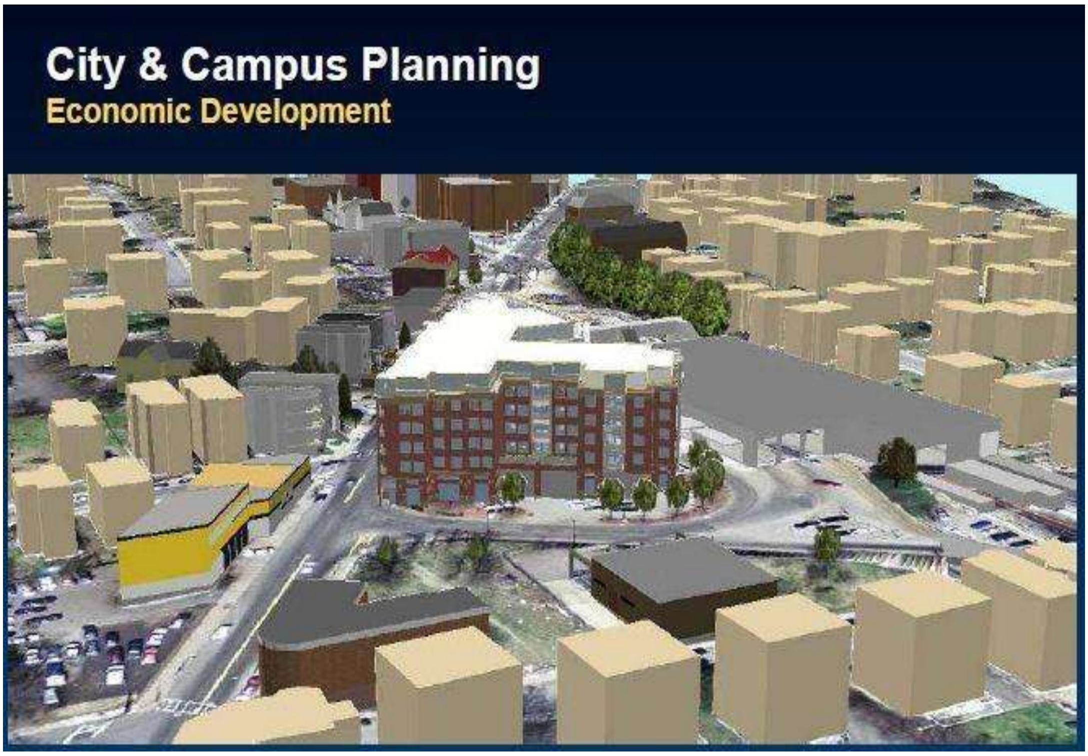

Figure 2: A Typical 3D-campus model

3.4 Data Manipulation

3.4.1 Space management

In this section, the land available and its usage is determined and analysed by simply computing the total area of the school land and then comparing the area occupied by each of the building to it. This is done by calculating the area of each of the many polygonal features, classifying each of the polygons to a class of buildings by querying buildings with specific similarities and then comparing it against the entire expanse of the school.

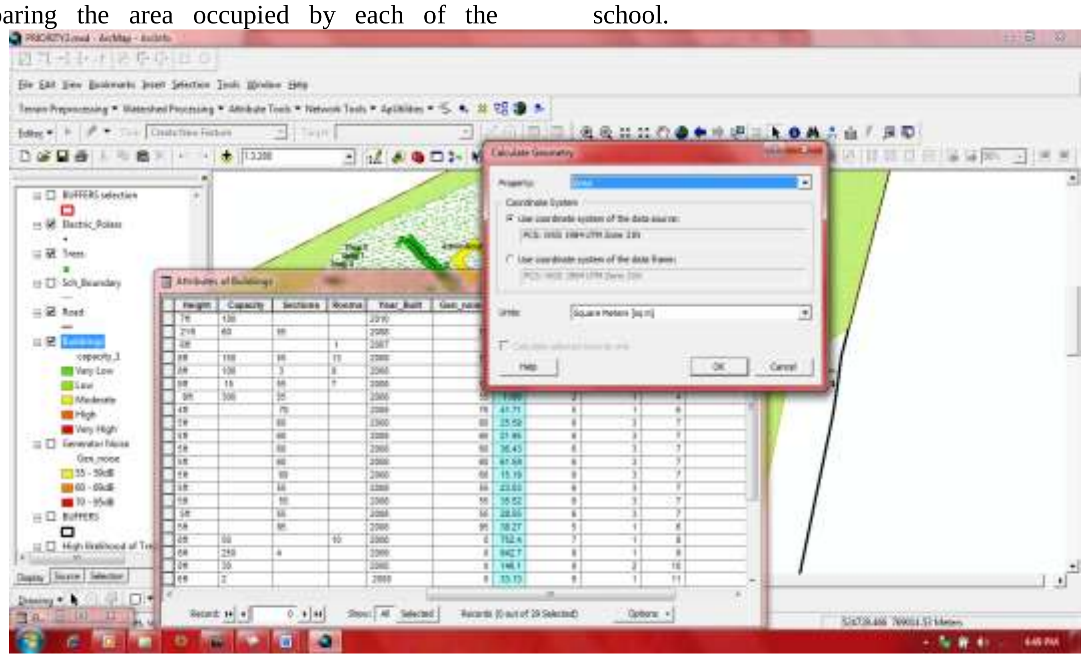

Figure 3: Area computation of various structures

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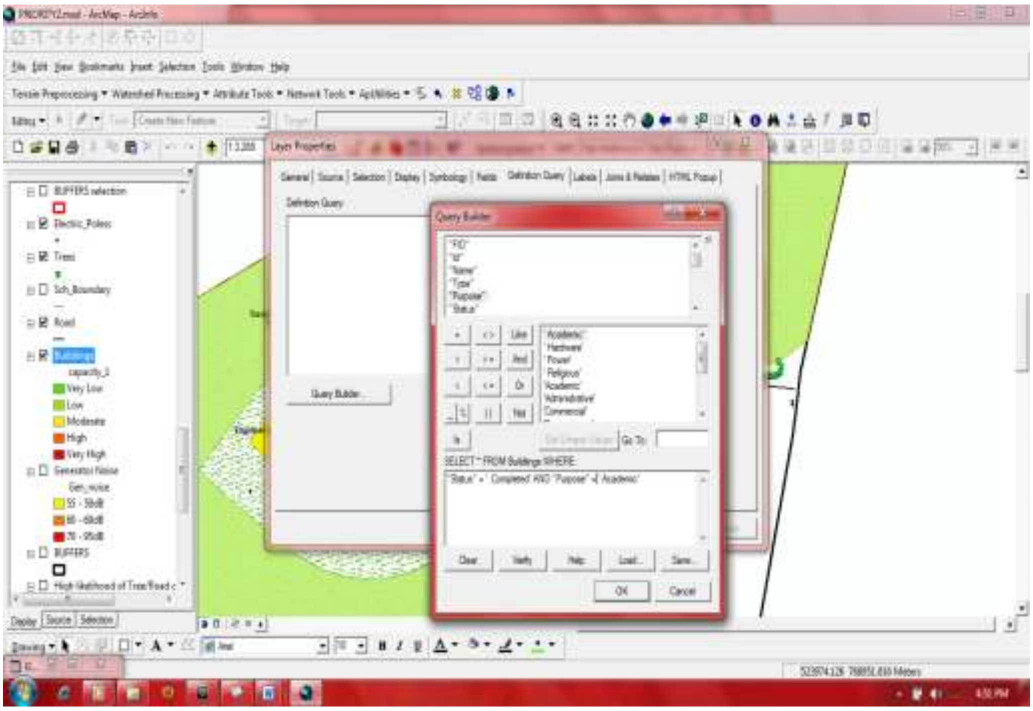

Figure 4: Querying the status of structures as well as their purpose

3.4.2 Trees locations management

It is known that trees are of immense benefits to the society and they also constitute nuisance when not properly planned and managed. To effectively plan and manage the utilization of tress to obtain it benefits, an area that should not be neglected is the spatial or location planning.

Spatial or location planning of efficient and appropriate use of trees to provide the necessary air cleansing and beautification involves the determination of the most appropriate location to site a tree; A place where it has adverse effect on the structures and, in general, human activities will be minimal if not completely averted. It is observed and experienced in our today's society that trees affect foundations of buildings and structures and these trees also inhibit the free movement of vehicles along roads and routes that are covered by trees or their branches.

To analyse the location of the trees within the school environment, the coordinates of the trees were obtained and plotted in the appropriate coordinate system. Since trees are measured on the average to have branches that spread out large enough to cover 4 meters radius. A 4 meters straight line distance around each of the trees is created using spatial analyst. The obtained raster is manipulated with a raster obtained from the roads to obtain a product that would reflect trees effects on the roads.

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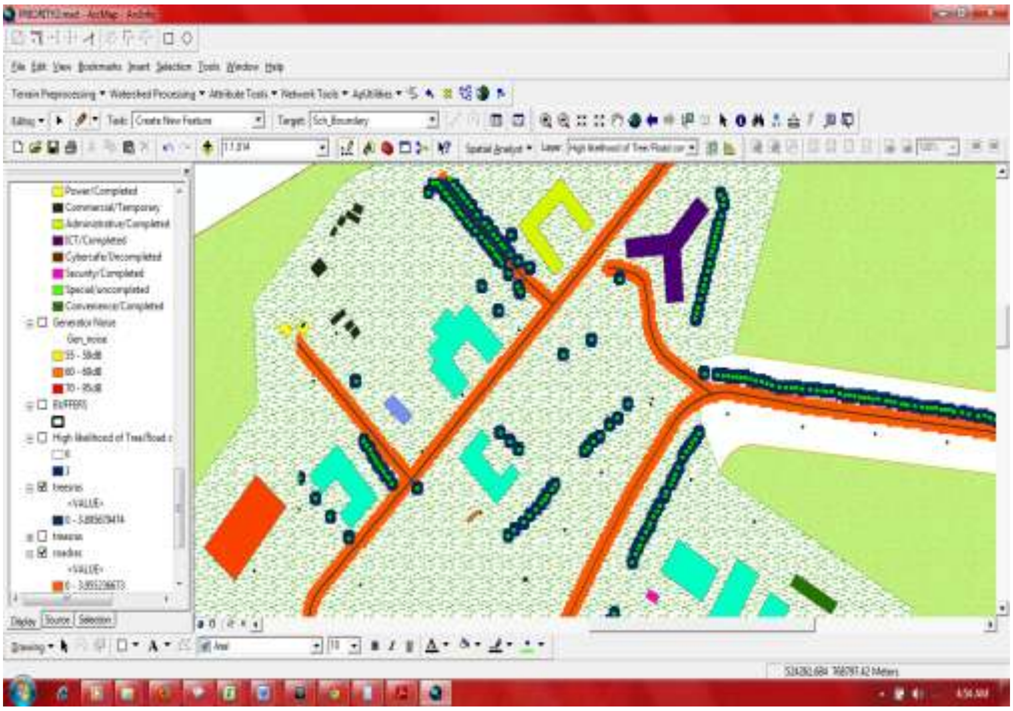

Figure 5: 4m distance to trees and road interaction

3.4.3 Noise management

As earlier stated, generator set and hence the generator house noise is produced by six major sources: Engine noise (100 dB(A) - 121 dB(A)); Cooling fan noise (100 dB(A) - 105 (A) dB); Alternator noise (80 dB(A) - 90 dB(A)); Induction noise (80 dB(A) - 90 dB(A)); Engine exhaust (120 dB(A) - 130 dB(A)); and Structural/mechanical noise. All measured at an average distance of one meter from the source. From the sound intensity information given by Cummins Power Generation Incorporation, the maximum sound intensity for a generator is 95dBA at 1 meter from the source with 85dBA being the lowest.

The resultant equivalent environmental noise level at one meter of 95dB(A) and 85dB(A) is obtained from the model below:

When measuring the sound pressure p (r) created by a sound source, it is important to measure the distance, r from the object as well, since the sound pressure of a spherical sound wave decreases as 1/r from the centre of the sphere (and not as $1/r^2$, like the sound intensity)

$$p(r) \propto \frac{1}{r}. \quad \text{.............................(1)}$$

This relationship is an inverse-proportional law.

Hence, the resultant of the two sounds heard is almost the sound of the highest intensity at a distance of one meter.

The sound/noise intensity suitable for learning ranges between 30dB for library environment and whisper, according to New York City Department of Environmental Protection (DEP) and Cummins Power Generation Inc respectively to 60dB, for normal conversation. Thus, where 60dB will be appropriate and fair for a lecturer delivering his lectures, 60dB would not be appropriate for a library. In determining the distance where a sound pressure of a particular value from the generator source would be experienced, knowing the sound pressure value at a distance of 1m from the generator, the model specified below, equation (3.2), is applied

If the sound pressure p_1 is measured at a distance r_1 from the centre of the generator, the sound pressure p_2 at another position r_2 can be calculated:

$$p_2 = \frac{r_1}{r_2} p_1. \quad \text{............... (2)}$$

The inverse-proportional law for sound pressure comes from the inverse-square law for sound intensity:

It therefore means any structure with a distance less than **58.95m** from the generator's house will experience some uncomfortable sound which is beyond the normal for conversation. In summary, at a distance of **58.95m** from the generator's house, a sound pressure of **60decibels** will be experienced. In the same vain, from figure 3.4 below, the smallest and largest concentric circles cover regions of at least70decibels and 55decibels respectively.

Sound pressure level (SPL) is the pressure level of a sound, measured in decibels (dB). It is equal to 20 x the Log[10] of the ratio of the Root Mean Square (RMS) of sound pressure to the reference of sound pressure (the reference sound pressure in air is 2 x 10-5 N/m2, or 0,00002 Pa). Or, in other words is the ratio of the absolute sound pressure against a reference level of sound in the air.

Sound pressure level (SPL) or **acoustic pressure level** is a logarithmic measure of the effective pressure of a sound relative to a reference value.

Sound pressure level, denoted L_p and measured in dB, is defined by

$$L_p = \ln\left(\frac{p}{p_0}\right)\text{Np} = 2\log_{10}\left(\frac{p}{p_0}\right)\text{B} = 20\log_{10}\left(\frac{p}{p_0}\right)\text{dB},$$

....(3)

where

- p is the root mean square sound pressure,
- p_0 is a **reference sound pressure**,
- 1 Np is the neper,
- 1 B = (1/2 ln 10) Np is the bel,
- 1 dB = (1/20 ln 10) Np is the decibel.

The commonly used reference sound pressure in air is

p_0 = 20 µPa,

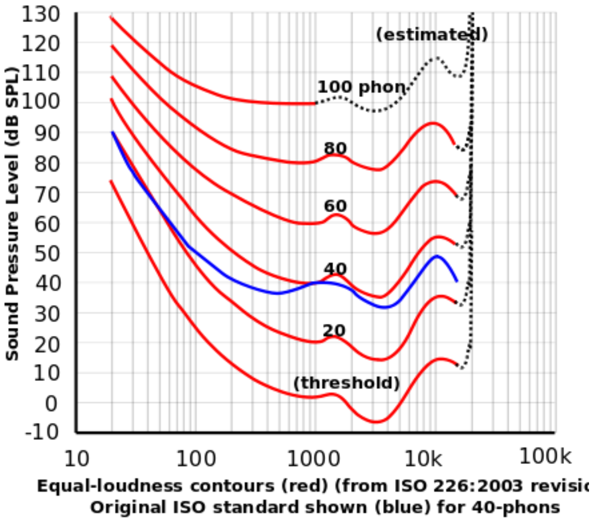

Figure 6: Sound Pressure Level in Decibel.: Equal-loudness contour, showing sound-pressure-vs-frequency at different perceived loudness levels

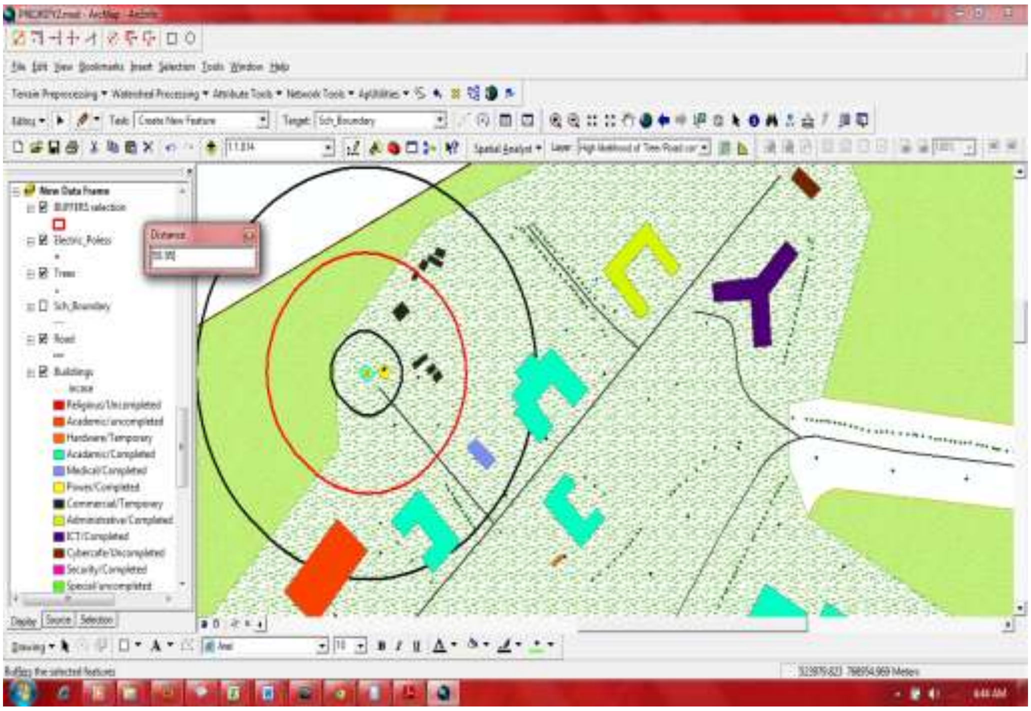

Figure 7: Buffers around generator house management

3.4.4 Emergency management and response

Once again, the whole school expanse of land wasanalysed for emergency purpose in the case of evacuation firstly in any event of a disaster. No one knows the location of the next disaster, but what is known for certain is the possible distribution of lives, that is, people within the environment. The capacity and hence the likelihood of persons present within a certain location is mapped and colour-coded. This will enable strategic location of emergency equipment such as the emergency buses or vehicles, for quick and timely response, and first aid materials, for instantaneous treatment, and thus reduce to the barest minimum the number of casualties or better still eliminate the possibilities of injuries.

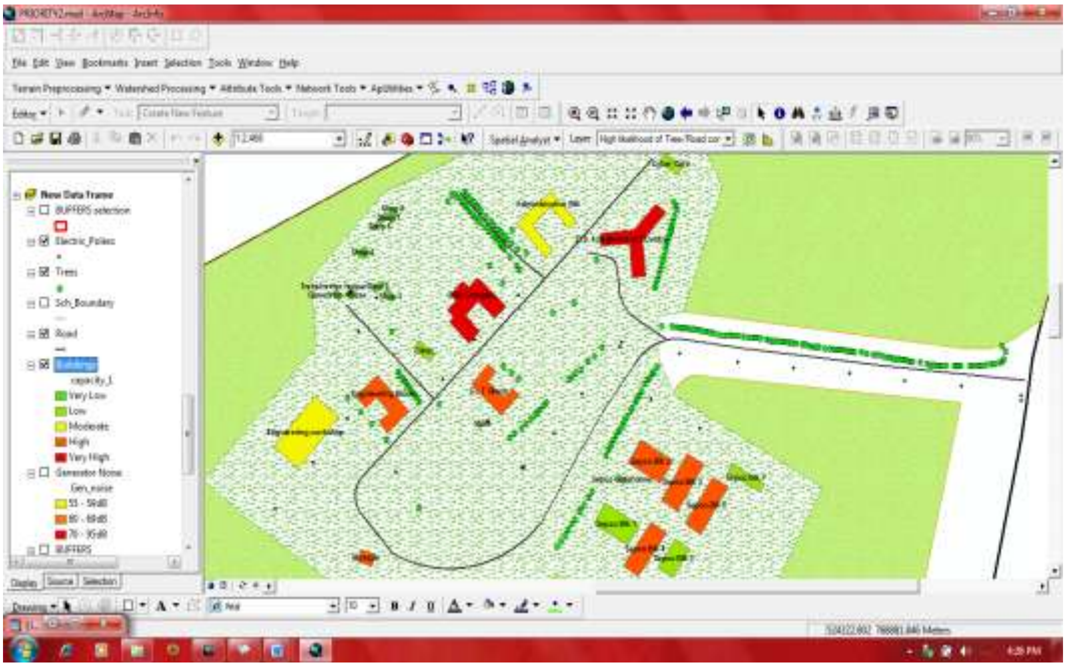

Figure 8: Relative likelihood of casualties for emergency planning and response

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IV. RESULTS AND DISCUSSIONS

4.1 Space management

The summation of the area occupied by the buildings is 10,082.50sqm and the total area, which is the expanse of land occupied by the school developed and undeveloped, is 1,452,000sqm or 1.45sqkm. This value goes to show the level of development within the school's vicinity, with less than one per cent (0.69%) of the school area being erected with building infrastructure in the school. The size of the occupied area is a clear indication of relatively low utilization of landmass in terms of infrastructure.

The school is majorly occupied by vegetation and grasslands; they eat up nearly about 93% of the school area. The vegetative area of the school takes up an area of 1,223,163.95sqm amounting to 83.24% of the school while the grassland claims an extent of 132217.9 sq. m which is 9.1% of the entire vicinity. About 6% of the school is composed of some other features not including buildings, vegetation and grassland, and not limited to roads

Table 1: Buildings and their respective areas

BUILDINGS	AREA(sq.m)
Mosque	119.1
Engineering workshop	1343
store	19.35
Engineering Block	760.5
SLT Block	569.1
Clinic	133.9
OGD Complex	1106
Transformer house	41.71
shop 1	25.59
shop 2	21.95
shop 3	36.43
shop 4	61.59
shop 5	15.19
shop 6	23.03
shop 7	35.54
shop 8	28.55
Generator house	38.36
Administrative Block	752.4
D.S. Adegbenro ICT Centre	942.79
Cyber Café	146.19

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Sepco Gatehouse	33.13
Sepco Block 1	611.9
Sepco Block 2	631.6
Sepco Block 3	693.7
Sepco Block 4	612.4
Sepco Block 5	385.1
Sepco Block 6	669.1
Sepco Block 7	225.3

Table 2: Features, areas and percentages of the occupied land mass

POLYGONAL FEATURES	AREA(sq.m)	PERCENTAGE OCCUPIED
Buildings	10082.5	0.69
Grass	132200	9.10
Vegetation	1223000	84.23
Unclassified	86717.5	5.97

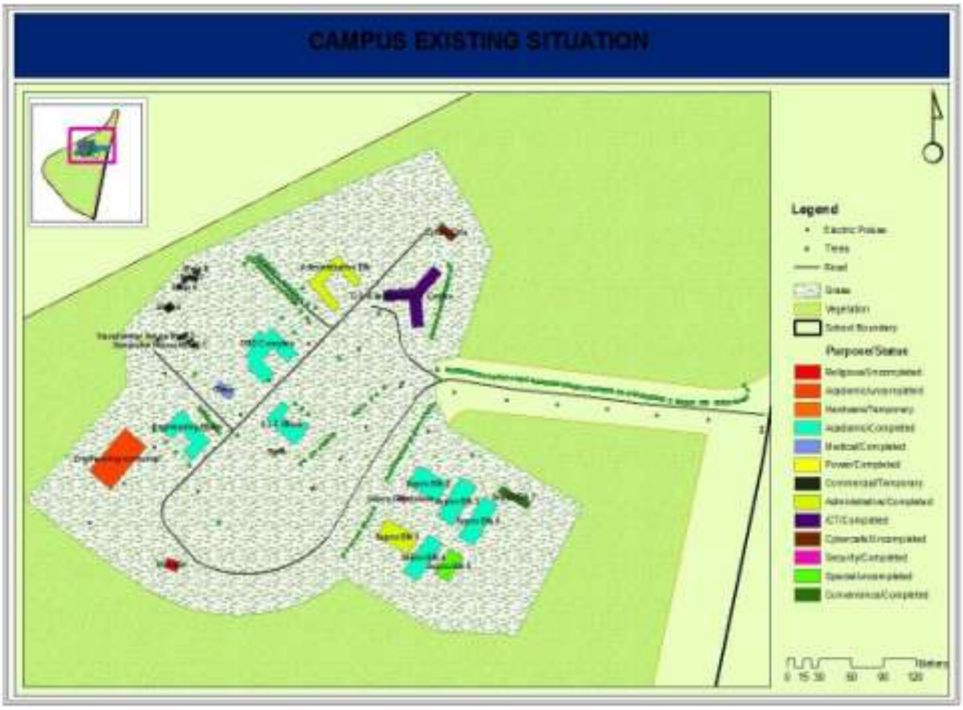

Figure 9: Map showing the campus situation at the time of study.

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4.2 Tree locations management

The tree distribution, trees lined adjacent the roads, is good for the academic environment as it helps to clean the air and reduce some noise. To eliminate road disturbances by trees, trees should be planted in excess of 4 meters from the road depending on the type. The results of the study and deep research shows some trees still have some level of interaction with the road, as some trees are less than 4 meters away from the road. This situation might pose serious threats and hazards on road users. However, the trees are properly spaced from poles and building structures and therefore pose little or no serious threat on power lines, their connectivity and buildings. Four (4)meters' buffer around each tree shows certain trees are cleared off the road while some are almost on the road. Specifically, trees around the road between the OGD complex and the Administrative Office Annexe, are less than 4 meters from the road and hence pose serious danger on road users which is regarded a tree-road conflict; Also some mild tree-road conflict exist along the school's entrance/exitroad.

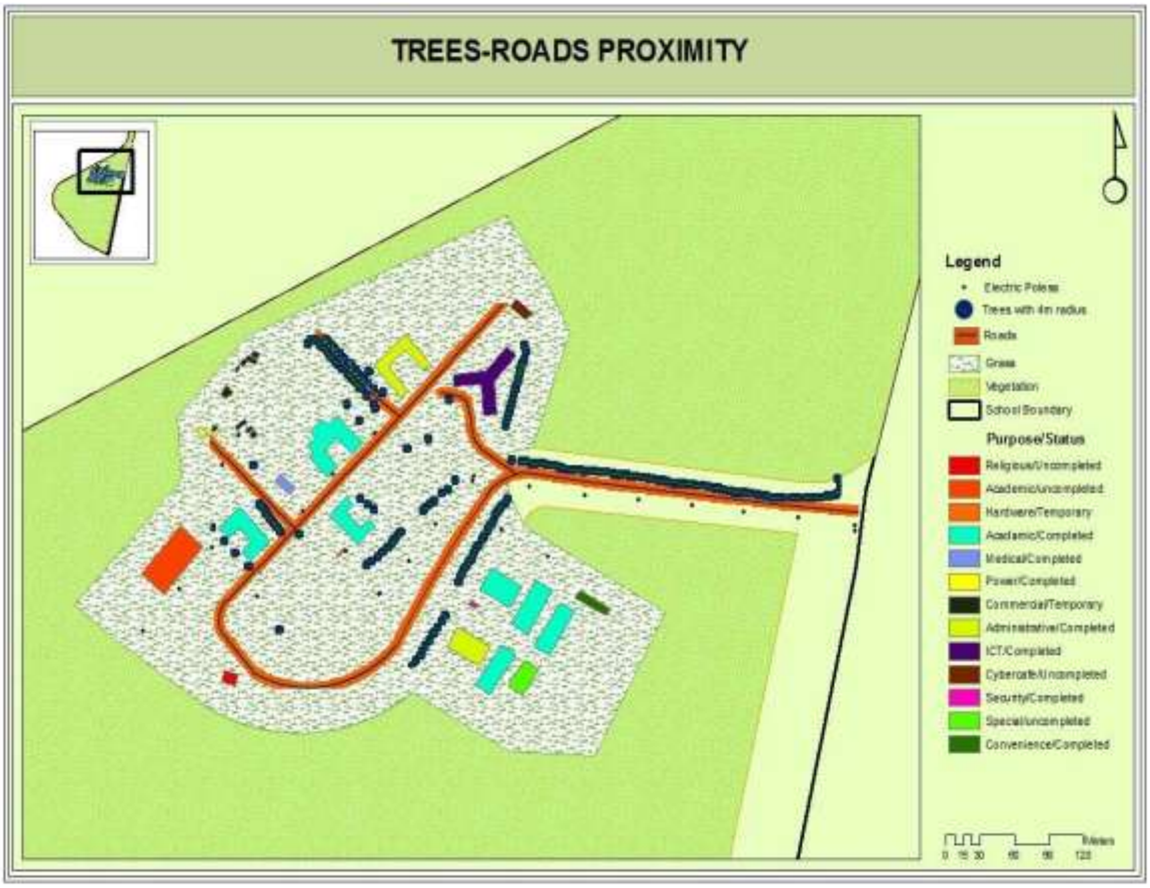

Figure 10: Map showing the nearness of the trees to the road

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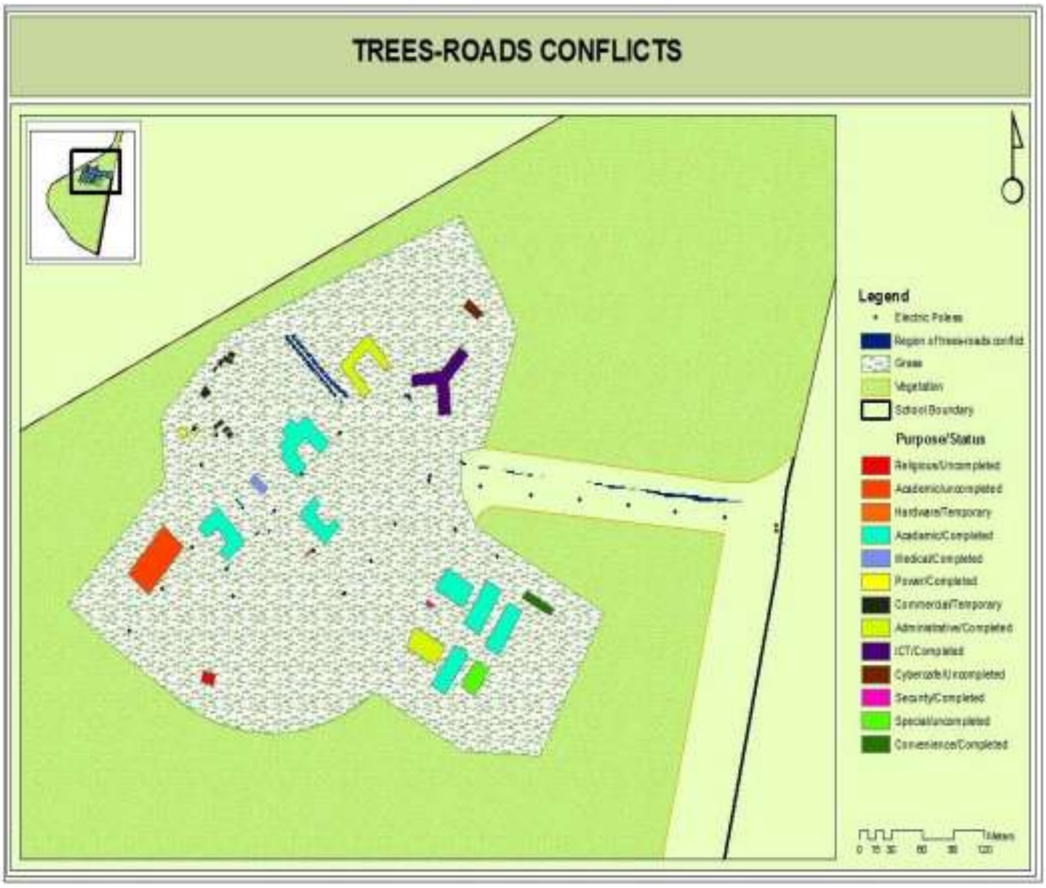

Figure 11: Map showing the region of trees-roads conflicts

4.3 Noise management

The largest producer of noise taking consideration of noise from traffic and Engineering workshop is the "generator" closely located to the power house. The generator produces noise that affects the academic community specifically structures within its immediate vicinity and other facilities depending on their distances from the generating source (Generator house). Generators are known on average to generate sounds that measures 95dB at a distance of 1 meter which spread radially from the source reducing as distance increases. This thus affects the surrounding building.

From the study, it is evident that a number of buildings fall within the distances 18meters, 58.95meters, and 104meters from the source, generator house. Within these buildings are shops, the generator house, the transformer house, OGD Science complex, Clinic, Engineering workshop and block. Out of the eight (8) shops, five (5) are located in a region that is considered noise prone i.e. region having noise range between **60-69dB**; the five shops are shops 1-5. The other three shops (shops 6-8) are located in a region that are relatively serene: an atmosphere convenient for teaching and learning. The noise intensity at the generator househarbours the largest noise level of about**95dB**, falling in the same classification of the buildings prone to noise disturbance. This class has a noise pressure value **70-95dB**. The other surrounding buildings not affected by the generator noise such as Clinic, Engineering workshop, Engineering block, OGD complex and shops 6-8 are strategically located as they are all erected in a region of a range between **55-59dB**where the sound pressure from the source has diminished considerably.

Other buildings not cited within the concentric circles as displayed in the map below are buildings that are substantially outside the sound hazardous zone.

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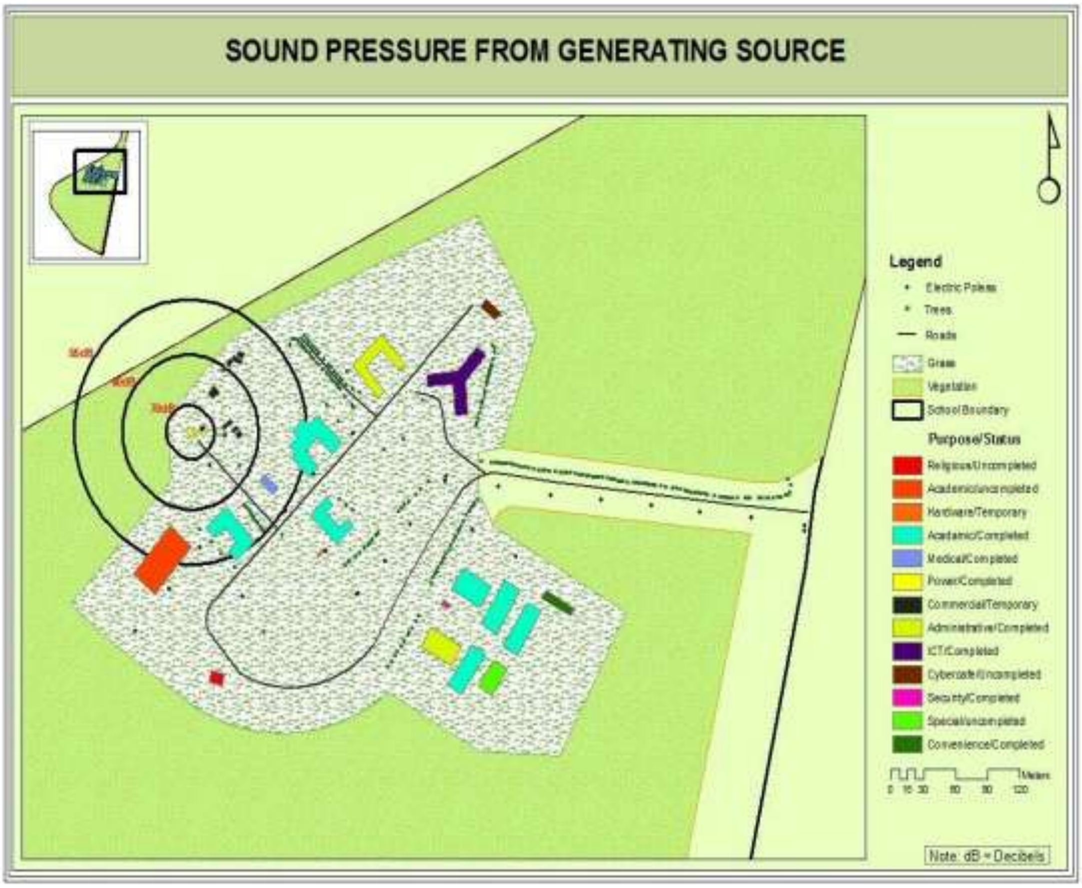

Figure 12: Map showing the variation of sound pressure from the generating source

4.4 Emergency planning and response management

For the purpose of this study, the campus was categorized into (1) very high (2) high (3) moderate (4) low and (5) very low populated buildings. It is evident that some structures are considered to house a good number of the school's population at the same time other buildings are holding a relatively lesser number. This people aren't limited to only the staff and students. The erected infrastructures which are to be known to house **VERY HIGH** population include the OGD complex and the D.S. AdegbenroICT Centre. Next to this category is the **HIGH** includingblocks 2, 3, 4 and 6 of SepcoIII buildings;SLT Laboratory; Engineering Laboratoryand thePolytechnic Mosque. The Engineering workshop and the Administrative Block come next in the **MODERATE** class, while SepcoIII Blocks 1, 5, 7; Clinic; and Cyber café fall within the category of the **LOW** class. The group that should be given least consideration when emergency is planned should be the **VERY LOW** category which includes all shops, transformer house and the generator house because they are located in the remote areaor closer to the fenceless boundary of the campus.

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Figure 13: Emergency planning and response map

V. RECOMMENDATION

- The space management study that shows the poor level of infrastructural development showed be looked into and corrected, so as to enable the campus house more facility and hence accommodate more students and staff.
- The tree locations management delineated specific region that should be considered for tree clearing, this should be implemented as soon as possible. Before citing any other tree seed in any location, the environmental impact assessment of having that kind of tree in that location should be appropriately done.
- In the sound management analysis, the research findingsdepicted the variation of sound throughout the campus generated by the generator, the major sound generator. Therefore, before erecting a building, the noise level needed for the building should be ascertained and thus the correct location to get not more than the required level.
- Lastly, the location of ambulances and other first aid materials should be determined with regards to the result of the emergency planning and response management. In other words, OGD complex and the D.S. Adegbenro ICT Centre should have emergency aids located within or next to them first as the aids get more and more available.

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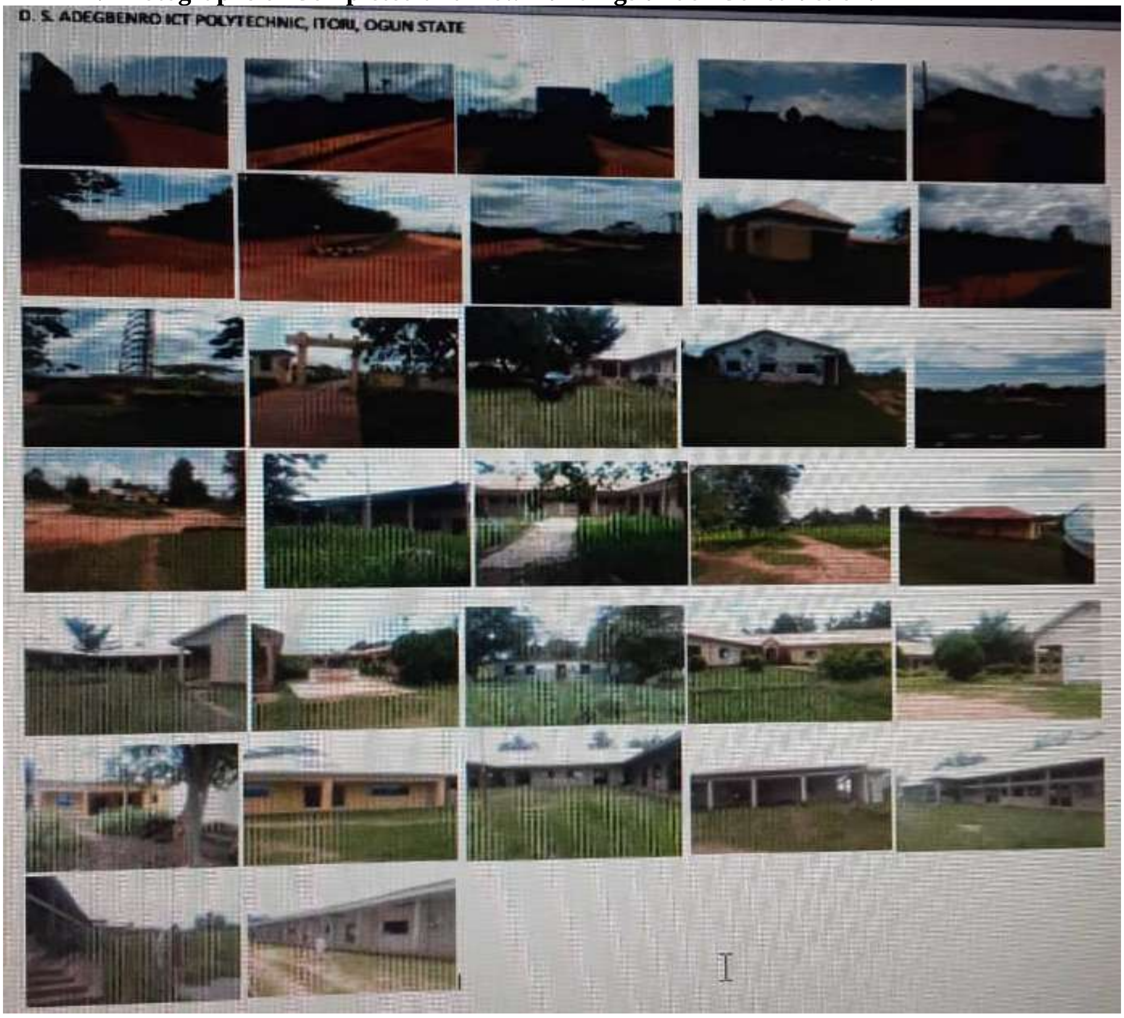
APPENDIX: Photographs of Completed and New Buildings under Construction.



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