

The Importance of Mapping Educational Facilities in A Fast-Growing Urban Settlement. Case Study Unwana, Ebonyi State

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Abstract- This research discusses the importance of educational facility mapping, the role of GIS in educational planning, issues of spatial distribution and accessibility, case studies in Nigeria, and the overall importance and challenges of mapping schools. It also identifies the gap this research intends to address, with particular reference to Unwana. Educational facility mapping involves the identification, documentation, and analysis of schools in relation to the communities they serve. It is a vital tool for educational planning and policy formulation. Olubadewo and Abiodun (2018) emphasize that school mapping reveals areas of inadequacy and guides governments in fair allocation of resources. According to Adepoju (2018), mapping provides insights into spatial disparities in education, enabling targeted interventions to promote equity. By presenting the actual distribution of schools, policymakers can better evaluate whether educational needs are adequately met. Importance of Mapping in Educational Planning: School mapping serves multiple critical purposes: It enables fair allocation of teachers, classrooms, and learning resources. It supports infrastructure development by identifying underserved areas. It provides reliable data for policy formulation (Adepoju, 2018; UNESCO, 2020). It functions as a monitoring tool and baseline for tracking educational progress (Bolstad, 2016).

Keywords: Facilities mapping, GIS, Spatial Data and ArcGIS

I. INTRODUCTION

Education is universally recognized as a fundamental driver of social, economic, and political development. One of the most effective ways of improving access to education and ensuring equity in service delivery is through the accurate mapping of educational facilities.

Educational facility mapping involves the systematic collection, analysis, and visualization of spatial data about schools, including their locations, accessibility, and attributes. Such mapping provides valuable insights for policymakers, planners, and researchers, particularly in contexts characterized by rapid urbanization, population growth, and uneven distribution of infrastructure (Adepoju & Akinyemi, 2019; Robinson et al., 2017).

In Nigeria, the distribution of schools is often shaped by socio-economic, cultural, and political factors rather than by coordinated spatial development planning. This has resulted in challenges such as overcrowding in urban schools, inadequate infrastructure in rural areas, and difficulty in monitoring educational standards (Adeniran, 2020).

Consequently, the mapping of schools using modern geospatial technologies such as the Global Positioning System (GPS) and Geographic Information Systems (GIS) has become indispensable for effective educational planning and management. GIS, in particular, provides a platform for integrating school data with other spatial layers, enabling planners to identify gaps, assess accessibility, and make evidence-based decisions (Clarke, 2015; Onasanya & Omosewo, 2011).

Against this backdrop, the mapping of primary and secondary schools in Unwana is both timely and relevant. Unwana, as a fast-growing urban settlement in Afikpo North Local Government Area of Ebonyi State, has experienced significant demographic changes that directly influence the demand and distribution of schools.

By creating a reliable spatial database of educational facilities, this study contributes to effective planning, equitable resource allocation, and informed decision-making by government agencies, private investors, and community stakeholders.

1.2 Statement of the Problem

Education is a key instrument for national development, yet its effectiveness depends largely on the availability, accessibility, and equitable distribution of educational facilities. In many developing countries, including Nigeria, there is inadequate information on the spatial distribution of schools.

This lack of reliable data often leads to poor planning, uneven allocation of resources, and neglect of certain communities. As a result, some schools suffer from overcrowding, while others operate with underutilized capacity and limited infrastructure (Adeniran, 2020).

In Ebonyi State, particularly in Afikpo North Local Government Area, the distribution of primary and secondary schools has largely evolved without the support of comprehensive spatial analysis. In Unwana, the administrative headquarters of the Local Government, schools have been established by both government and private individuals to meet growing educational demand. However, there is no existing geospatial database that captures their exact locations, attributes, and accessibility.

This makes it difficult for policymakers, planners, and education managers to assess whether schools are optimally sited, adequately serving their catchment populations, or equitably distributed across the town.

Furthermore, demographic changes, rural–urban migration, and increasing enrollment have intensified the pressure on available facilities in some areas while leaving others underserved. Without accurate spatial information, it becomes nearly impossible to make evidence-based decisions regarding the siting of new schools, upgrading of existing ones, or monitoring of accessibility and equity in educational provision (Adepoju & Akinyemi, 2019).

Therefore, the central problem this study addresses is the absence of a reliable spatial database of primary and secondary schools in Unwana, which limits effective planning and resource allocation. By employing Geographic Information Systems (GIS) to map and analyze these schools, this project seeks to fill the gap by providing accurate, accessible, and decision-supportive data for educational development in the area.

1.3 Study Area/Location

Unwana is the administrative headquarters of Afikpo North Local Government Area in Ebonyi State, Southeastern Nigeria. Geographically, it lies approximately between latitude 5°45'N and 5°55'N and longitude 7°55'E and 8°05'E. The town is strategically located along the banks of the Cross River and shares boundaries with major settlements such as Afikpo town, Itim, and parts of Amasiri (Okoro, 2018).

The climate of Unwana is typically tropical, with distinct wet and dry seasons. The rainy season spans from April to October, while the dry season lasts from November to March. The area records an average annual rainfall of about 2,000 mm, and mean temperatures range between 22°C and 32°C (NIMET, 2021).

The favorable climate and fertile soils support agriculture, which is the dominant occupation of the inhabitants. Fishing also plays a significant role in the local economy due to the proximity of the Cross River.

Administratively, Unwana is notable for hosting the Akanu Ibiam Federal Polytechnic, which has made the town a vibrant educational hub that attracts students, staff, and visitors from across Nigeria. The community is composed of various villages and quarters, exhibiting both urban and rural characteristics.

The coexistence of government-owned and privately-owned schools reflects the town's expanding population and growing demand for education. Mapping these schools provides a clearer understanding of their spatial distribution,

accessibility, and relationship with other land uses within the area.



Fig 1.0 Map of Nigeria showing Ebonyi State



Fig 2.0 Map of Ebonyi state showing Afikpo (Unwana)

1.4 Aim

The primary aim of this study is to develop a digital map of primary and secondary schools in Unwana.

1.5 Objectives of the project

1. To conduct reconnaissance survey of the study area.
2. To obtain the base map of the project Area.
3. To collect the geographic coordinates (X, Y, Z) of identified schools.
4. To produce a digital map using GIS applications.
5. To analyze and present the spatial distribution of schools in the study area.

1.6 Significance of the Study

This research is significant in multiple dimensions. First, it provides the researcher with hands-on experience in digital mapping and systematic project execution. It further enhances practical skills in cartography and the use of GIS software (ArcGIS 10.8) to generate maps that highlight the location of schools and other features in Unwana. Beyond

academic value, the study contributes to educational planning by offering reliable spatial data that can guide policymakers, assist planners in equitable resource allocation, and serve as a reference database for future researchers.

1.7 Duration of the Project

The project activities began on 19th August, 2025, and concluded on 30th September, 2025

1.8 Scope of the Project

This study is limited to mapping all primary and secondary schools within Unwana community, Afikpo North LGA, Ebonyi State. The scope covers the acquisition of spatial data using handheld GPS devices for geographic coordinates, alongside attribute information such as school name, type (primary or secondary), ownership (public or private), and location description.

The data were processed using ArcGIS 10.8 to produce thematic maps that show school distribution, accessibility, and spatial patterns. Key deliverables include georeferenced maps, attribute tables, and analytical reports.

1.9 Structure and size of the project

Order of the Project:

This project falls under the third-order survey classification, which provides a reasonable balance between accuracy and precision. Surveys of this order are widely applied in topographic mapping, land subdivision, cadastral surveys, and construction works. They are typically carried out using standard surveying equipment such as handheld GPS receivers and total stations.

Scale of the Project:

The scale of the project corresponds to the total spatial extent of the study area

Area Covered:

The study area, Unwana, encompasses an estimated landmass of about 19,000 hectares.

2.1 PLANNING / METHODOLOGY

The project was carefully planned under the guidance of our supervisor, with contributions from all group members, to be successfully completed within six weeks (August to October).

During the planning stage, we deliberated on the instruments required for data collection, which included a handheld GPS receiver (Garmin eTrex 10), field book, and personal protective equipment (PPE). Since no existing base map of the study area was available, it was also agreed that satellite imagery would be adopted as the foundation for the project.

2.1.1 Data Search

The datasets used for this project were obtained from both primary and secondary sources.

Primary Data

Geographic coordinates of school sites in the study area acquired using a GPS receiver.

Secondary Data

Satellite imagery of the study area sourced from Google Earth.

Road networks and other visible features digitized from the satellite imagery.

Additional site information (e.g., hotel location) obtained during ground visits.

2.2 Reconnaissance

A reconnaissance survey was conducted prior to the main fieldwork. This preliminary activity involved visiting the study area to identify the location of schools, observe surrounding features, assess possible obstacles, and determine the availability of control points within the area.

2.3 Instrumentation

Instrumentation refers to the selection of appropriate tools to achieve the desired accuracy in digital map production. The choice of instruments during reconnaissance was guided by:

1. Adoption of a modern survey approach.
2. Ability of the instruments to achieve the required accuracy.
3. Availability of instruments.
4. The limited time frame for project execution.

The instruments selected were:

Garmin handheld GPS

Field book, pen, and safety jackets

Laptop computer with relevant software (Google Earth, ArcGIS, MS Word, MS Excel)

2.3.1 Test of Instruments

The testing of instruments is a vital preparatory step before commencing any field survey. It is necessary for a surveyor to examine and, where required, adjust instruments in order to reduce observational errors. This procedure confirms that the equipment is in proper working condition before being taken to the field and subsequently applied in the project.

In this study, the Garmin handheld GPS was subjected to verification to identify potential errors and make the necessary adjustments. A reference point (Point A) with known northing and easting coordinates was measured using the GPS device.

The instrument was allowed to remain active for about 15 minutes to establish satellite connections, after which the recorded coordinates were taken as Point B. A comparison between Point A and Point B was then carried out to evaluate the accuracy of the GPS prior to its deployment for data collection.

Table 2.0 showing the instrument test

S/N	EXISTING COORDINATE		OBSERVED COORDINATE	DIFFERENCES	REMARKS
A	N650854.286	B	N650853.618	0.668	OK
	E380847.197		E380848.276	0.921	OK

2.4 Equipment / System Selection and Software

The hardware and software used for this project are listed below:

Hardware

- Handheld GPS
- Computer system
- Printer
- Field book
- Safety jacket

Software

- ArcGIS (version 10.4/10.8)
- Google Earth (for imagery and visualization)
- Microsoft Word
- Microsoft Excel

2.5 Personnel

Surv. Azubuike Fortunatus – Project Supervisor
 Ntuen Nnabu Udo – Group Leader
 James Evans – Member
 Philip Joseph – Member

2.6 Methodology

Data Acquisition

Data acquisition involved collecting both geometric and attribute information. The coordinates of schools were obtained using a handheld GPS (accuracy + 3m). The device was properly initialized before use, and all coordinates were recorded using the WGS 84 Zone 32N projection system. Data was later transferred to a computer for processing.

Attribute Data Collection

Attributes such as school name, students' population, category (primary/secondary), ownership type, availability of ICT facilities, and location details were recorded in the field book and later digitized.

2.7 BASE MAP

A base map provides the reference framework for a digital map by displaying essential features like roads, buildings, and boundaries. For this project, high resolution satellite imagery from Google Earth was used as the base ma. The process involved:

- i. Accessing Google Earth to view the study.
- ii. Zooming in on the project location.
- iii. Selecting and appropriate imagery date.
- iii. Downloading and saving the image for use in ArcGIS.



Fig 3.0 Screenshot Of Google Earth Launched

2.8 Control Points for Geo-referencing

Control points are precisely determined reference locations used to align spatial datasets to their correct

geographic positions (J.R. Marr et al., 2003). For this project, control points were extracted from Google Earth using the following steps:

1. Locate the point of interest on the imagery.
2. Right-click and select "What's here" to obtain the coordinates.
3. Copy the Coordinates and paste them into a text editor.
4. Save the coordinates for later geo-referencing in ArcGIS.

Table 2.1 shows the control point chosen

POINT ID	EASTING	NORTHING (M)
Afikpo road	380998	641541
Police station road	382194	641011
The Presbyterian road	381933	640555
Inside AUFPU	380595	380545

2.9 Geo-Spatial Data Capture

Geo-spatial data capture refers to the collection and organization of spatial Information for mapping and analysis. For this project, it involved:

1. Field Data Collection: GPS receivers were used to record the coordinates of schools. Ground-truthing confirmed the existence and positions of schools, while noting features not visible on imagery.
2. Satellite Imagery and Base Map: High-resolution imagery from Google Earth provided background data for mapping.
3. Attribute Data Recording: School names, categories, ownership, and other attributes were recorded and digitized.
4. Data Integration into GIS: Both spatial and attribute data were imported into ArcGIS 10.8. Data was geo-referenced using UTM Zone 32N, Minna Datum, to ensure

positional accuracy.

This systematic approach ensured that both geometric and descriptive information about schools in UNWANA were accurately captured, processed, and prepared for mapping and analysis.

4.0 Data Analysis, Results and Presentation

This chapter presents the analysis of data collected during the fieldwork for the mapping of primary and

secondary schools in Unwana. The results obtained from the field survey and secondary data sources are analyzed, interpreted, and presented in both tabular and cartographic forms. The analysis provides a spatial understanding of the distribution, accessibility, and characteristics of schools in the study area.

School Name	Primary	Secondary	Private	Public	ICT	Coordinate (NM)	Coordinate (EM)
Comprehensive Secondary sch. Unwana		secondary		public	yes	641607	381018
Akanu Ibiam Staff Poly. Sec. School Unwana		secondary	private		yes	641530	379866
Akanu Ibiam Staff Poly. Pri. School Unwana	primary		private		yes	641583	380265
Lady OlayinkaIbiamMemoralPri.Sch Unwana	primary			public	No	641063	382157
Wisdom & Excellence child academy Nur/pri	primary		private		No	640737	382212
St Thomas Nursery/primary sch. Unwana	primary		private		No	640258	382099
The Presbyterian Nur/Pri& secondary Unwana	primary	secondary	private		No	640555	381933
Unwana community Primary school Unwana	primary		private	public	No	641011	382194
AmakomNur/primary School Unwana	primary		private		No	640615	381996
Genius (solid) foundation Academy Nur/Prim. Sch.	primary		private		No	640972	381358

3.0.1 Data Analysis

The data acquired during reconnaissance and fieldwork comprising coordinates obtained with the Garmin eTrex 10 GPS receiver, attribute information (school name, type, ownership, and location), and base map data, were subjected to processing and analysis using ArcGIS 10.8 software.

Key stages of the data analysis included

1. Coordinate Plotting: Conversion of the acquired GPS coordinates into point features in ArcGIS.
2. Digitization: Creation of polygon layers representing the study boundary and road networks.

3. Database Design: Input of attribute data such as school name, level (primary or secondary), and ownership (public or private).
4. Spatial Query and Analysis: Identification of spatial distribution patterns of schools within Unwana.
5. Geo-referencing: Integration of field data with satellite imagery and control points for accurate mapping.

III. RESULTS

The results of the analysis reveal the following: A total of 7 primary schools and 3 secondary schools were identified and mapped within Unwana.

Schools are concentrated in certain zones, with sparsely distributed facilities in outlying areas. Ownership analysis shows that 40% are public schools while 60% are private schools.

Accessibility analysis indicates that most schools are located along major roads, while a few are relatively remote.

These results provide insight into the educational infrastructure within Unwana and highlight areas requiring attention in terms of educational planning and equitable distribution

Presentation of Results

The results are presented in various formats to enhance understanding:

1. Tables: Summary tables showing the list of schools, their coordinates, and ownership status. Statistical tables displaying the number of schools by category (primary vs. secondary, public vs. private).
2. Maps: Location Map of primary and secondary schools in Unwana. Ownership Distribution Map showing public and private schools. Accessibility Map displaying the relationship between schools and the road network.
3. Charts/Graphs: Bar charts comparing the number of primaries vs. secondary schools.

Pie charts showing the percentage distribution of public and private schools.

These visual presentations aid in better comprehension of the spatial distribution and characteristics of schools in Unwana.

3.1 Geo-Referencing

Geo-referencing is the process of aligning a map, image, or spatial dataset to real-world coordinates by using control points. Control points are specific, well-defined locations whose positions are already known and can be matched with their corresponding positions on a reference map or GIS database.

These points are used to “fit” or “adjust” the image so that it corresponds accurately with the base map or dataset. In simple terms, geo-referencing ensures that a map or image is correctly oriented and spatially consistent with real-world geography. Once geo-

referencing is completed, the map can be reliably used for spatial analysis and other GIS operations.

In this project, the digital map was geo-referenced in ArcGIS through the following steps:

- i. ArcGIS software was launched and the digital map was added to the map document.
- ii. A new blank map was created for the operation.
- iii. The coordinate system was defined as WGS 84 by right-clicking the data frame in the Table of Contents, selecting Properties, and setting the desired coordinate system.
- iv. The Google Earth image was inserted into the data frame using the Add Data tool from the Home panel, after navigating to the folder where the image had been saved under the group name.
- v. Using the Add Control Points tool, X and Y coordinates were assigned to the image to establish accurate spatial referencing.
- vi. Finally, the image was rectified and the updated alignment was saved through the Geo-referencing toolbar.



Figure 3.2 A Screenshot showing the geo-referencing process in action

3.2 Digitization and Data Conversion

Digitization refers to the process of transforming analogue data such as images and maps into digital format, producing vector layers that can be managed and analyzed within ArcGIS software. This procedure ensures that all spatial features are systematically captured and stored for further geospatial analysis.

The steps carried out in this project include:s

- a. A geodatabase, which serves as the main container for spatial datasets, was created in ArcCatalog by establishing a connection to the project group folder.

- b. Feature classes were created within the geodatabase for all spatial elements to be digitized, such as roads, buildings, and school locations.
- c. The Editor tool was activated, and each feature was digitized individually by selecting Create Features from the editing panel.
- d. The acquired coordinates were plotted using the Go to XY tool in the main toolbar, ensuring that the exact position of each feature was correctly located for accurate detailing.
- e. Attribute information was assigned by inserting text labels, where the names and descriptions of the digitized features were input accordingly.
- f. Essential map elements such as legend, scale bar, north arrow, and coordinate system were inserted through the Insert option in the main menu.
- g. Grid coordinates were incorporated by adjusting the Data Frame Properties, providing a spatial reference framework for the map.
- h. Finally, the completed digital map was exported in PDF format by selecting File → Export Map, making it suitable for presentation and documentation.

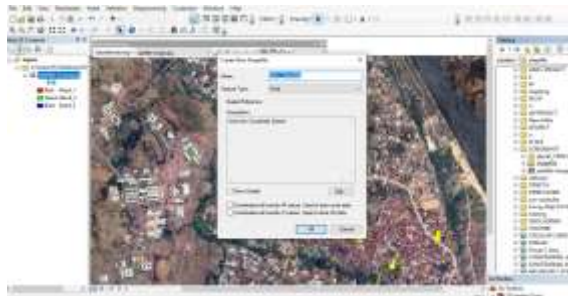


Fig 3.3: A screenshot showing the digitizing process in action

3.3 Coordinate Plotting

The procedures followed in plotting the coordinates are outlined below:

- a. A base map of Unwana was acquired and loaded into the ArcMap environment using the “Add Data” function of the software.
- b. A shapefile for the XY coordinates was generated and imported into ArcCatalog, after which it was added to ArcMap for further analysis.

- c. The school locations were identified on the map, and the Callout Tool was applied to display and verify the exact positions of the schools on the map.

4.4 GIS Data Base Design and Creation

The creation of a GIS database entails structuring and storing spatial datasets in an efficient manner to support quick retrieval and effective analysis.

1. Identify the Purpose and Requirements: Define the objective of the database (e.g., mapping schools in Unwana). Decide what types of data are needed (spatial layers and attribute tables).
2. Conceptual Design: Outline the data model (points for schools, lines for roads, polygons for boundaries). List the attributes that will describe each feature (e.g., school name, type, ownership).
3. Logical Design: Establish relationships between datasets (e.g., each school point linked to its attribute table by a unique ID). Plan how data will be stored, queried, and updated.
4. Physical Design and Creation: Create a Geodatabase in GIS software (e.g., ArcGIS or QGIS) to serve as the container. Build feature classes (points, lines, polygons) and tables to store attribute data.
5. Data Entry and Integration: Input spatial data (coordinates, digitized features, or shapefiles). Populate attribute tables with field information collected (school name, category, enrollment, etc.) Ensure each spatial feature is linked with its correct attributes.
6. Data Organization: Group related datasets into layers (e.g., schools, roads, boundaries). Apply proper naming conventions and folder structures for easy management.
7. Data Storage and Management: Save all data within the Geo-database to ensure consistency. Use metadata (descriptions of data content and source) to enhance understanding and usability.
8. Quality Control: Check for errors such as duplicates, missing records, or incorrect coordinates. Apply topology rules to maintain spatial integrity (e.g., no overlapping polygons, correct snapping).
9. Analysis and Accessibility: Test the database by performing queries (e.g., locate all secondary schools in a given ward). Organize outputs (maps,

tables, charts) to allow quick retrieval and interpretation.

10. Backup and Maintenance: Create secure backups of the database to prevent data loss. Update the database regularly with new information for sustainability

3.5 Ground Truthing

Ground truthing refers to the procedure of confirming the reliability and correctness of data obtained during the field survey

Procedures:

- Visiting each hotel site to cross-check details such as contact information, available facilities, and current operational condition.
- Collecting additional descriptive information through discussions with hotel staff or guests to enrich the attribute data.
- Integrating the validated information into the ArcGIS database while correcting any errors discovered during the verification process.
- Conducting a final assessment of the dataset to guarantee completeness and precision before finalizing the project.

4.1 Discussion, Conclusion and Recommendation

The mapping of primary and secondary schools in Unwana has provided a clearer understanding of the spatial distribution, accessibility, and educational infrastructure within the study area. The findings revealed that schools are not evenly distributed, with a higher concentration located around the central and more developed parts of the town, while some peripheral communities have fewer educational facilities. This imbalance may affect accessibility, especially for pupils and students residing in the outskirts, who often travel longer distances to access formal education.

The integration of field-collected data with GIS technology ensured accurate location plotting and attribute information for each school. Through georeferencing, digitization, and database creation, the study successfully produced digital maps that highlight the exact positions of schools, their categories (primary or secondary), and related characteristics. This approach not only improved data accuracy but also made the information easier to

analyze and present for educational planning purposes.

Ground truthing further strengthened the reliability of the results by validating the GPS coordinates and attributes of schools on-site. This step minimized errors and ensured that the final maps reflected the real situation on the ground. The process also revealed some discrepancies between official records and actual field observations, particularly regarding the operational status and infrastructural condition of certain schools.

The spatial analysis underscores the importance of GIS as a tool for decision making in the education sector. With a functional database and visual representation of school locations, stakeholders such as policymakers, local authorities, and community leaders can now identify underserved areas, plan for equitable distribution of schools, and allocate resources more efficiently. The outputs of this project can also support future educational development programs and act as a baseline for subsequent studies or monitoring activities.

In summary, the discussion highlights that while Unwana has made progress in the provision of educational institutions, there is still a need for improved planning to ensure balanced distribution, enhanced accessibility, and better infrastructure for both primary and secondary schools.

4.2 Problems Encountered and Solutions

During the course of this research project, several challenges were encountered in the process of data acquisition, analysis, and map production. These problems, together with the solutions adopted, are outlined below:

1. Accessibility to Some School Locations

Problem: Certain schools were difficult to access due to poor road networks, long distances, and unfavorable weather conditions during fieldwork.

Solution: Alternative routes were explored with the help of local guides, and in some cases, motorcycles were used to reach the schools. Fieldwork schedules were also adjusted to favorable weather periods.

2. **Incomplete or Inconsistent School Records**
Problem: Some schools lacked adequate records such as enrollment statistics, establishment year, and infrastructure data, which made attribute data collection challenging.
Solution: Interviews were conducted with head teachers, staff, and community members to validate and complement missing information. This ensured the database remained reliable.
3. **Technical Limitations of GPS Device**
Problem: The handheld GPS occasionally produced coordinate shifts due to satellite signal obstruction by tall buildings, trees, or cloudy weather.
Solution: Multiple readings were taken at each location at different times of the day, and the average values were used to improve accuracy.
4. **Limited Availability of High-Resolution Imagery**
Problem: The satellite imagery accessible in ArcGIS and Google Earth did not always provide high clarity for detailed digitization.
Solution: The imagery was enhanced through proper geo-referencing, and supplementary field sketches were incorporated to improve map accuracy.
5. **Financial Constraints**
Problem: The cost of printing maps, acquiring data, and logistics for field visits posed financial challenges.
Solution: Expenses were minimized through proper budgeting, cost-sharing among group members, and support from well-wishers and academic mentors.
6. **Time Limitation**
Problem: The duration allocated for project completion was relatively short compared to the wide coverage of schools within the study area.
Solution: A well-structured timetable (Gantt chart) was prepared and strictly followed. Tasks were divided systematically to maximize efficiency.

4.3 Conclusion

This study successfully carried out the mapping of primary and secondary schools in Unwana, Afikpo North Local Government Area of Ebonyi State, using modern geospatial technologies. By integrating Global Positioning System (GPS) data, satellite imagery, and Geographic Information System (GIS)

applications, a reliable spatial database of schools in the area was created.

The findings revealed that the distribution of schools in Unwana is uneven, with higher concentrations in central and accessible zones, while peripheral areas remain underserved. The analysis further showed that privately owned schools outnumber government-owned institutions, reflecting the growing role of private investment in educational development. Most schools are situated along major roads, which enhances accessibility, but certain remote areas still face challenges of reach and service delivery.

Through the creation of georeferenced maps, attribute tables, and spatial analysis outputs, the project demonstrated how GIS can serve as a powerful decision-support tool in educational planning. The study also highlighted the practical importance of reconnaissance, coordinate plotting, database design, digitization, and ground-truthing in producing accurate and usable maps.

In conclusion, the project filled the critical gap of lacking a reliable spatial database of schools in Unwana. The outputs serve not only as a reference for policymakers, planners, and education stakeholders but also as a baseline for further research and development initiatives.

4.4 Recommendations

Based on the findings of this study, the following recommendations are made to improve educational planning and service delivery in Unwana:

1. **Government Intervention in Underserved Areas:** Authorities at the local and state levels should prioritize the establishment of additional schools in peripheral and underserved communities to ensure equitable access to education across the study area.
2. **Improved Infrastructure and Accessibility:** Roads and transport facilities leading to schools, especially in remote areas, should be developed or rehabilitated to enhance accessibility for both students and teachers.
3. **Strengthening Public Education:** Since privately-owned schools outnumber government schools, deliberate policies should be enacted to strengthen

public schools through adequate funding, provision of teaching aids, staff motivation, and infrastructure upgrades.

4. Integration of GIS in Educational Planning: The use of GIS should be institutionalized by the Ministry of Education and Local Government Councils for continuous monitoring, updating, and management of educational facilities. This will ensure effective decision-making and resource allocation.
5. Regular Data Update and Future Research: The spatial database created in this project should be updated regularly to capture new schools, infrastructural changes, and demographic shifts. Future researchers can expand this study by integrating additional variables such as student population, teacher distribution, and performance indices.

4.5 Contribution to Knowledge

This research has made significant contributions to knowledge in the following ways:

1. Creation of a Spatial Database: The study developed the first comprehensive and georeferenced spatial database of primary and secondary schools in Unwana, which can serve as a reference point for planners, policymakers, and researchers.
2. Application of Modern Geospatial Techniques: By integrating GPS, satellite imagery, and GIS software, the study demonstrated the practical application of modern geospatial tools in solving real-life educational planning challenges.
3. Identification of Spatial Patterns in School Distribution: The research revealed the uneven distribution of schools in Unwana, highlighting areas of concentration and areas that are underserved. This insight provides an evidence-based foundation for equitable educational development.
4. Decision Support for Stakeholders: The project established how GIS outputs such as georeferenced maps, attribute tables, and spatial analysis can be used as decision support tools for resource allocation, accessibility analysis, and policy formulation in the education sector.
5. Baseline for Further Studies: The findings and outputs of this study provide a baseline for future

research in related fields, such as accessibility modeling, school performance analysis, and demographic impact studies, thereby expanding the frontier of geospatial applications in education.

4.6 Suggestions for Further Research

This study focused on the spatial distribution of primary and secondary schools in Unwana. While it has provided valuable insights, further research is recommended in the following areas:

1. Accessibility Modeling: Future studies could incorporate advanced GIS techniques such as network analysis to assess the travel time and distance students cover to reach schools.
2. Educational Quality Assessment: Researchers may examine how spatial distribution relates to quality indicators such as teacher–student ratios, availability of learning facilities, and academic performance.
3. Demographic and Population Dynamics: Integrating population growth, age distribution, and migration patterns into the spatial database would provide a deeper understanding of current and future educational needs.
4. Comparative Studies: Expanding the scope to cover other towns within Afikpo North or across Ebonyi State would allow for regional comparisons and broader policy recommendations.
5. Integration of Remote Sensing and Real-Time Data: Future research could adopt high-resolution satellite imagery, drone mapping, and real-time data collection tools to improve accuracy, monitoring, and timely updates of school locations.
6. Impact of Policy and Private Investment: Further research may analyze how government policies and private sector participation influence the establishment and distribution of schools.

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