

**PERIMETER SURVEY AND DIGITAL MAPPING OF FACULTY OF
ENVIRONMENTAL SCIENCES UNIVERSITY OF BENIN UGBOWO CAMPUS**

BY

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ENV2002792



**A PROJECT SUBMITTED TO THE DEPARTMENT OF GEOMATICS,
FACULTY OF ENVIRONMENTAL SCIENCES,
UNIVERSITY OF BENIN, BENIN CITY,
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF
BACHELOR OF SCIENCE (B.Sc) DEGREE IN SURVEYING AND
GEOINFORMATICS.**

NOVEMBER, 2025

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DEGREE, IN THE FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF
BENIN, BENIN CITY, EDO STATE, NIGERIA.

NOVEMBER, 2025

CERTIFICATION

This is to certify that this project was carried out by OMROGBE OSAZEMWINDE JONATHAN with Matriculation Number ENV2002792 of the Department of Geomatics, Faculty of Environmental Sciences, University of Benin, Edo State, Nigeria.

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HEAD OF DEPARTMENT

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EXTERNAL EXAMINER

Date

DEDICATION

This work is dedicated to God almighty, for His grace, wisdom and strength throughout this academic journey. I also dedicate it to my parents and siblings for their unconditional love, and support during the course of this project.

ACKNOWLEDGEMENT

My sincere gratitude goes to Almighty God, the Giver of life, knowledge, and strength, for His divine guidance, protection, and enablement throughout the duration of this project and my academic journey.

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offer my sincere appreciation. Your contributions, no matter how small, did not go unnoticed.

ABSTRACT

Accurate spatial information and up-to-date infrastructural documentation are essential components of effective campus planning, facility management, and sustainable development in tertiary institutions. This project focuses on the perimeter survey and digital mapping of Faculty of Environmental Sciences complex University of Benin, Ugbowo Campus using Total Station technology. The aim of the study is to produce a perimeter survey, a detailed topographic map of the complex.

Data acquisition were carried out using a Total Station instrument, which enabled the precise measurement of horizontal distances, elevations, and angular observations required for boundary delineation. Field observations were coordinated using established control stations within the campus. The collected field data were processed with appropriate surveying and CAD software to generate a perimeter map, spot-height-based topographic map.

The final outputs provide accurate spatial Information essential for campus inventory, infrastructure documentation, planning, and future development purposes. This study demonstrates the effectiveness of Total Station technology in producing reliable geometric data and detailed maps, thereby reinforcing its continued relevance in modern surveying and digital mapping applications. The results contribute to the growing digital geospatial database of the University of Benin and serve as a reference for future campus mapping.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Surveying is a fundamental discipline in the development, planning, and management of physical environments. It involves the measurement and mapping of the earth's surface to produce accurate spatial information required for land administration, engineering design, and infrastructural development. Over the years, surveying practices have evolved from conventional chain and compass methods to modern electronic and digital surveying systems, improving precision, efficiency, and data management.

The introduction of electronic distance measurement instruments and Total Station technology marked a major advancement in surveying. A Total Station combines electronic distance measurement (EDM) and angle measurement with automated data recording capabilities, allowing surveyors to collect accurate three-dimensional spatial data efficiently. This technology has become essential in engineering surveys, construction layout, topographic mapping, and cadastral work due to its high accuracy and versatility.

The Faculty of Environmental Sciences, Ugbowo Campus, has experienced significant expansion in recent years, with the construction of new academic buildings, administrative complexes, and support facilities. As new structures continue to emerge, it becomes necessary to update the university's spatial database and physical development records. Accurate perimeter and topographic data of newly built structures support campus planning, facility management, land documentation, and future expansion activities.

However, in many institutions, spatial information systems are not frequently updated, leading to outdated or incomplete records. Conducting a perimeter survey and generating digital maps of Faculty of Environmental Sciences, Ugbowo Campus provides a reliable record of current infrastructural development. This study therefore employs a Total Station

to obtain precise spatial data for the perimeter survey of the new constructed buildings within the Faculty of Environmental Sciences complex, as well as the topography of the immediate surroundings. The resulting digital mapping output provides an updated and accurate spatial representation that can support decision-making and physical planning within the university environment.

1.2 STATEMENT OF THE PROBLEM

Universities are dynamic environments that undergo continuous physical growth and infrastructural development. As new buildings and facilities are constructed, it becomes essential to maintain updated spatial records for effective planning, land administration, and facility management. Despite the rapid expansion within the Faculty of Environmental Sciences complex, existing maps and spatial data do not fully capture recently developed structures. Outdated or incomplete mapping information can lead to challenges in campus planning, construction supervision, utility layout, land boundary management, and documentation of property assets.

Furthermore, in many academic institutions, spatial data updates are often delayed due to limited digital survey operations and dependence on traditional mapping techniques. Without accurate and current survey data, campus development decisions may be based on incorrect spatial information, resulting in planning errors, land disputes, and inefficient facility management.

Therefore, there is a need for a precise perimeter survey and digital mapping of newly built structures within Faculty of Environmental Sciences to update existing spatial records. This study addresses this gap by using a Total Station to collect and process accurate positional and topographic data, thereby producing up-to-date perimeter maps and topographic maps.

1.3 AIM AND OBJECTIVES

AIM:

The aim of this project is to carry out a perimeter survey and produce digital maps of newly built structures within the Faculty of Environmental Sciences using a Total Station.

OBJECTIVES:

The specific objectives of this study are to:

1. Produce a perimeter map of the study area.
2. Produce a topographic map of the study area.

1.4 SCOPE OF THE STUDY

This study is focused on the perimeter survey and digital mapping of selected newly constructed buildings within the University of Benin, Ugbowo Campus. It covers all field and office procedures required for the acquisition, processing, and presentation of accurate spatial data. The work involves using the established survey control within the study area and using a Total Station as the sole instrument for data collection. The study includes obtaining boundary measurements for the perimeter survey, capturing spot heights and relevant physical features for topographic detail. All field observations are processed using appropriate surveying and CAD software to generate a perimeter map and a topographic map. The study is limited to the designated portion of the Faculty of Environmental Sciences and does not include subsurface utility mapping, structural analysis, or the use of GNSS or any other survey equipment. It is strictly confined to the use of Total Station technology for data acquisition and digital mapping of the selected buildings and their immediate surroundings.

1.5 JUSTIFICATION OF THE STUDY

The rapid infrastructural development within the University of Benin has created a pressing need for updated spatial data to support effective campus planning and facility management. Existing maps and records do not adequately reflect newly constructed buildings and current ground conditions in some areas of the campus, which may result in

planning discrepancies, inefficient land management, and difficulties in future expansion. Conducting a perimeter survey and digital mapping is therefore justified to ensure accurate documentation of campus development. The use of Total Station technology is particularly appropriate as it provides high-precision measurements required for reliable mapping outputs, including boundary definition and terrain representation. Beyond institutional benefits, this study is also justified academically as it provides practical exposure to modern surveying techniques, reinforces theoretical knowledge, and contributes to the body of surveying and geoinformatics research within the university. By producing accurate maps and building documentation, this work supports long-term campus development, enhances the availability of reliable spatial information, and demonstrates the practical importance of digital surveying methods in contemporary land and infrastructure management.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Surveying remains one of the oldest and most fundamental technical professions supporting land development and infrastructure management. (Uren and Price, 2010). Its significance lies in its role in measuring, mapping, and documenting the physical environment to support decision-making in construction, planning, engineering, land administration, and resource management. (Wolf and Ghilani, 2012). Historically, surveying relied heavily on manual instruments such as chains, tapes, compasses, and optical theodolites to measure distances, angles, and boundaries. (Schofield and Breach, 2007). While these traditional methods played a foundational role, they were often time-consuming and susceptible to human error. (Ghilani, 2017). Over time, advancements in engineering and electronic measurement technologies revolutionized surveying, enabling greater precision, efficiency, and automation in spatial data capture. (Kavanagh and Slattery, 2014).

One major breakthrough in modern surveying is the introduction of the Total Station. Combining the functions of a theodolite, an electronic distance measurement device, and a microprocessor, the Total Station has significantly transformed field data acquisition. (Chandra, 2015). It allows surveyors to measure horizontal and vertical angles, slope distances, and automatically compute coordinates with high accuracy. Its data-storage feature eliminates many manual computations and transcription errors common in traditional methods. (Kavanagh and Slattery, 2014). As campuses, cities, and infrastructure become increasingly complex, the use of Total Station has become essential for accurate

perimeter surveys, topographic surveys, and architectural measurements, including building floor plan documentation. (Wolf and Ghilani, 2012)

The need for accurate spatial data is even more pronounced in rapidly expanding academic environments. Universities such as the University of Benin continually undergo infrastructural growth—new faculties, research buildings, administrative blocks, and student facilities are being developed. (Oladapo and Ibronke, 2013). As a result, campus spatial records must be frequently updated to support effective planning, development control, asset inventory, and facility management. In many universities, out dated or incomplete spatial information has led to difficulties in infrastructure monitoring, land allocation, and campus planning. (Aderoju and Olayinka, 2019) Literature from similar studies highlights how accurate maps and digital survey records contribute immensely to informed decision-making and sustainable campus development.

Furthermore, as higher institutions embrace digital transformation, accurate spatial databases form an integral part of smart campus systems, digital mapping, and geospatial information management. (Ismail, Mahmud and Rahman, 2020). Documenting new structures and campus modifications ensures that the university maintains a reliable spatial database that supports academic, administrative, and facility-maintenance functions. This research aligns with such goals by applying Total Station technology to collect, analyze, and present accurate spatial data for newly built structures within UNIBEN. (Ezeomodo and Nwilo, 2016).

Thus, this literature review aims to explore concepts central to this study, including land surveying, digital mapping, perimeter and topographic surveying, and building measurement techniques. (Wolf and Ghilani, 2012). It also examines the technological evolution leading to the adoption of Total Stations, discusses relevant theories of spatial data acquisition and cartography, and reviews empirical studies conducted in similar

institutional settings. (Lillesand *et al.*, 2015). Through this review, the study situates itself within existing literature, demonstrates its necessity, and highlights how it contributes to modern surveying practice and campus development. (Aderoju and Olayinka, 2019).

2.2 CONCEPT OF LAND SURVEYING AND DIGITAL MAPPING

Surveying and mapping are grounded in a number of theories that guide the acquisition, processing, and presentation of spatial data. (Ghilani, 2017). The theoretical foundation for perimeter surveying and digital mapping is built on fundamental surveying principles, geodesy, measurement theory, and spatial data representation. These theories support the accuracy, reliability, and scientific basis for the techniques employed in modern land measurement and mapping processes. (Vaníček and Krakiwsky, 1986).

One of the core theories underpinning this study is the theory of terrestrial surveying, which states that all survey measurements are referenced to the Earth's surface and are carried out using distance and angular observations. (Schofield and Breach, 2007). This theory emphasizes that accurate determination of relative positions on the Earth depends on precise horizontal and vertical angle measurements as well as distance observations, which Total Stations are designed to provide. The instrument combines optical angle measurement and electronic distance measurement (EDM) to determine coordinates using trigonometric principles such as triangulation, trilateration, and intersection methods. (Kavanagh and Slattery, 2014).

Another important theoretical concept is geodetic and plane surveying theory. While geodetic surveying considers the curvature of the earth in extensive surveys, plane surveying assumes the earth to be a flat surface for small areas. Since this project covers a limited portion of the University of Benin, the plane surveying theory is applicable, allowing coordinates and distances to be computed using Cartesian geometry and plane trigonometry without significant error due to earth curvature. (Ghilani, 2017).

Additionally, the theory of control survey plays a fundamental role. Control points serve as reference stations for locating additional points in the study area. This theory ensures that measurements are tied to a common coordinate system, improving the accuracy and consistency of the final maps. (Schofield and Breach, 2007). The Total Station enables establishment of temporary control points through precise angular and linear measurements, forming the basis for perimeter determination and topographic data acquisition. (Uren and Price, 2010).

The study also draws from the theory of mapping and cartographic representation, which provides guidelines for the conversion of field-measured data to graphical form. (Lillesand *et al.* 2015). This involves the principles of scale, projection, symbolization, contouring, and coordinate plotting. Topographical representation theory explains how elevation data is translated into contour lines and spot heights to depict terrain variations, which is essential in producing an accurate and readable topographic map. (Slocum *et al.*, 2009).

Finally, the production of building floor plans is guided by the theory of architectural measurement and drafting, which focuses on accurate internal dimension acquisition, structural representation, and the use of orthographic projection for building plans. This ensures that internal spaces, walls, windows, and structural components are captured and represented correctly. (Emmitt and Gorse, 2014).

Overall, the theoretical background establishes the scientific basis for measurement accuracy, coordinate computation, data referencing, and map production. It provides the foundation that links traditional surveying concepts to modern digital mapping techniques employed through Total Station instrumentation. (Wolf, and Ghilani, 2012).

2.3 PERIMETER SURVEY AND BOUNDARY MAPPING

Perimeter Surveying refers to the measurement and determination of the boundary lines of a parcel of land. It involves establishing the legal and physical boundaries of a selected site

by measuring distances, angles, and bearings between boundary points. (Uren *et al.*, 2010). This concept is fundamental in land administration, property ownership, and physical planning. In this study, perimeter surveying ensures that the exact spatial extent of the selected area within the University of Benin campus is accurately defined, allowing for proper mapping and documentation. (Enemark, *et al.*, 2014).

Topographic Mapping is the process of representing natural and man-made features on the Earth's surface, including variations in terrain elevation. It relies on systematic data collection and contour representation to illustrate the three-dimensional nature of land on a two-dimensional plane. (Slocum *et al.*, 2009). The concept highlights the importance of elevation data, spot heights, and contour intervals in analyzing terrain for planning and development. Within this project, topographic mapping assists in identifying slope, drainage direction, and relative heights of structures and surrounding land features in the study area. (Lillesand, *et al.*, 2015).

Digital Mapping refers to the use of digital tools and software to create, manipulate, and store spatial information in graphical form. Unlike traditional manual drafting, digital mapping integrates automated coordinate computation, electronic data capture, and computer-aided design (CAD) platforms for enhanced precision and visualization. (Kraak, *et al.*, 2020). This study applies digital mapping techniques through software platforms to process field measurements collected using the Total Station, resulting in highly accurate perimeter maps, topographic maps, and floor plan drawings.

Total Station Surveying is the concept of using an electronic instrument that combines electronic distance measurement (EDM), angular measurement, and computational functions to determine precise spatial positions. (Kavanagh and Slattery, 2014). Total Stations integrate optical theodolites and distance measurement functions, supported by onboard data storage and coordinate computation capabilities. This concept represents a

major advancement in surveying practice, replacing manual and analog techniques with automated precision. (Uren and Price, 2010). In this project, the Total Station is used for point collection, boundary measurement, topographic detail acquisition, and building interior measurements.

Coordinate System and Reference Framework form an essential conceptual component, as they define how measured points are referenced spatially. Surveying measurements must relate to a consistent coordinate system to ensure accuracy and usability. This involves establishing a local coordinate framework or tying to an existing campus control system. The concept ensures that all data collected in the study area is spatially connected and mathematically consistent. (Vaníček, and Krakiwsky, 1986).

Floor Plan Representation is the conceptual process of measuring and drafting internal building details in a two-dimensional plane to show walls, openings, room layouts, and other architectural features. Floor plans provide a horizontal cross-section of a structure at a specified height, typically showing internal arrangements and spatial relationships. In the context of this study, the concept involves capturing internal dimensions and features of the selected buildings and converting them into accurate architectural floor plans. (Emmitt, and Gorse, 2014).

Collectively, these concepts provide the foundation for understanding how spatial information is acquired, processed, and represented. They guide the methodology of this project and ensure that the resulting survey outputs perimeter boundaries, topographic maps, and building floor plans are accurate, scientifically reliable, and professionally usable for planning and academic reference. (Bolstad, 2019).

2.4 CONCEPT AND RELEVANCE OF TOPOGRAPHIC SURVEYING

Topographic surveying refers to the systematic process of measuring and recording the physical features and elevation variation of a given land surface. Unlike boundary or

cadastral surveys that focus on defining property limits, topographic surveys provide detailed information about the terrain, including slope, natural landforms, drainage patterns, vegetation, and man-made features such as buildings, roads, and utilities. (Uren, and Price, 2010). The primary objective is to obtain three-dimensional data points that accurately represent both horizontal and vertical characteristics of the land.

This form of surveying plays a vital role in engineering, land development, environmental studies, and physical planning, as it provides baseline information for design, analysis, and decision-making. Using Total Station instruments, surveyors capture precise spot heights and detail points that are later processed to generate contour lines, digital elevation models (DEMs), and terrain surfaces. (Wolf and Ghilani, 2012). These representations facilitate effective visualization and terrain interpretation, allowing planners and engineers to understand existing landform conditions before proposing construction or infrastructure projects.

Topographic surveying is highly relevant to modern infrastructure development because it supports tasks such as road alignment, drainage design, building placement, and landscape engineering. It ensures that project designs are compatible with the natural environment and that land use decisions are technically guided. (Uren *et al.*, 2010). In this project, topographic surveying enables accurate assessment of elevation differences, building platforms, walkways, and surrounding landscape features within the University of Benin environment, contributing to detailed and reliable spatial mapping. (Wolf and Ghilani, 2012).

2.4.1 CAMPUS TERRAIN AND INFRASTRUCTURE PLANNING

University campuses, such as the University of Benin, require detailed spatial planning to support academic, residential, and infrastructural development. The terrain within a campus environment influences road layout, building positioning, landscape design, storm water

drainage systems, pedestrian circulation, and utility distribution. An accurate understanding of the terrain helps administrators and planners create functional, safe, aesthetically appealing, and environmentally sustainable facilities. (Wolf and Ghilani, 2012).

Topographic data collected within a campus setting is used to model slopes, identify natural drainage paths, determine earthwork requirements, and detect elevation constraints that may affect building foundations or engineering utilities. In addition, campus terrain models support the planning and maintenance of green areas, sports facilities, access routes, and drainage channels.(Uren, and Price, 2010). The detailed survey information derived from the Total Station assists in generating base maps that serve as reliable reference frameworks for future development.

In the context of this study, the terrain and built structures within the selected section of the University of Benin campus will be surveyed and digitally modelled to reflect realistic site conditions. This promotes accurate documentation, supports existing academic planning initiatives, and aids infrastructural management by providing up-to-date spatial information. (Wolf and Ghilani, 2012). Ultimately, the integration of topographic surveying and terrain modelling enhances campus development strategies, ensuring efficient land utilization and proper infrastructure coordination. (Wolf *et al.*, 2012).

2.5 SURVEYING EQUIPMENT AND DATA PROCESSING

Surveying operations require appropriate instruments and techniques to ensure accuracy, reliability, and systematic data acquisition. In modern surveying practice, equipment selection is guided by the nature of the project, the required accuracy, and expected output. (Kavanagh *et al.* 2014). For this study focused on perimeter survey, topographic mapping, and building floor plan production the primary instrument is the Total Station, supported by ancillary field and office tools. (Kavanagh, *et al.*, 2014).

Surveying Equipment: The key equipment used in this project include;

Total Station: The Total Station serves as the primary data acquisition instrument. It integrates an electronic theodolite for precise angular measurement and an Electronic Distance Measurement (EDM) system for accurate linear measurement. It also features internal computation functions and electronic data storage. (Uren and Price, 2010). The Total Station enables efficient measurement of boundary points, detail features for topographic mapping, and internal and external building corners for floor plan production.

Survey Tripod: A stable tripod is used to support the Total Station during observations. The tripod ensures that the instrument remains steady to achieve high-precision angular and distance readings. (Uren and Price, 2010).

Prism and Prism Pole: A prism mounted on a pole is used as the target reflector for EDM operations. It facilitates the measurement of long distances and detail points by reflecting the EDM signal back to the instrument. (Uren and Price, 2010).

Measuring Tape and Staff: Though the Total Station performs most measurements electronically, measuring tapes are used for short distance checks, offset measurements, and auxiliary tasks. A leveling staff may also be used for height references where necessary. (Uren *et al.*, 2010).

Field Book / Digital Data Recorder: Although data is stored electronically in the Total Station, notes and sketches may be recorded in a field book for referencing station setups, feature descriptions, and building orientation.

Accessories: Tools such as plumb bob, reflectors, batteries, chargers, and stationery support smooth field operations. (Kavanagh *et al.*, 2014).

2.5.1 Data Processing and Software Environment

After field measurements, the collected coordinate and detail information undergoes systematic processing and conversion into usable spatial outputs. This process ensures

accuracy, consistency, and the generation of final survey products such as perimeter maps, topographic plans, and floor drawings.

Data Downloading: Measured data is transferred from the Total Station to a computer through data cables, memory cards, or Bluetooth, depending on instrument specifications.

Coordinate Computation: Recorded horizontal angles, vertical angles, and slope distances are processed to compute Eastings, Northings, and elevations of surveyed points. Most Total Stations perform initial computation internally, but secondary processing ensures correctness.

Software Processing: CAD and survey software are used for:

1. Plotting perimeter boundary points
2. Generating topographic features and spot levels
3. Producing contour lines where required

Software likely to be applied includes AutoCAD, CivilCAD, or other survey-supported CAD environments.

Editing and Adjustment:

Survey data undergoes corrections where necessary to remove outliers and ensure closure accuracy, particularly for perimeter surveys. Geometric checks such as traverse adjustments, orientation corrections, and closure computations are performed to confirm measurement integrity.

Map and Plan Production:

The final stage involves the graphical representation of processed data in the form of:

Perimeter plan/map showing boundary lines, bearings, and distances, Topographic map with features such as buildings, pathways, ground elevations, and spot heights, Floor plans with detailed room divisions, walls, openings, and relevant annotations

Appropriate scales, north arrows, coordinate grids, and legends are applied to enhance clarity and professional presentation.

2.6 Accuracy, Challenges, and Limitations in Total Station-Based Surveying

Surveying with a Total Station is widely recognized for its precision and reliability in engineering and mapping applications. However, like all scientific measurement processes, accuracy levels are influenced by instrument capability, environmental conditions, operator experience, and field procedures. Understanding these factors is essential in ensuring high-quality perimeter surveys, topographic mapping, and building floor plan production.

2.6.1 Accuracy Considerations in Total Station Surveying

The accuracy of Total Station operations is dependent on proper control point establishment, instrument calibration, and systematic observation techniques. Total Stations combine electronic distance measurement (EDM) and angular measurement to compute precise coordinates; hence, errors in either component affect the overall positional accuracy. (Wolf *et al.*, 2012).

To ensure accuracy:

1. Instrument setup is levelled properly using optical/laser plummet and compensators.
2. Orientation is established using known coordinates or back-sighting techniques.
3. Multiple observations and resection/traversing methods are used for control verification.
4. Environmental effects such as temperature and atmospheric pressure are considered, as they influence EDM readings.
5. Error-minimizing practices such as repeated measurements, distance checks with tape for short spans, correct prism positioning, and systematic point numbering enhance accuracy. In building surveys, short distances and internal reflections also require careful instrument alignment and multiple setups for full visibility.

2.6.2 Practical Challenges in Field Data Collection

Although Total Stations improve surveying efficiency, certain field conditions may still pose difficulties. Common challenges in this study may include:

1. **Line-of-Sight Obstruction:** Trees, parked vehicles, and structural elements may block instrument-to-prism visibility, especially inside buildings.
2. **Campus Activities:** Human movement, vehicles, and daily academic activities within University of Benin may cause temporary observation interruptions.
3. **Sunlight/Glare:** Excessive glare on prism or instrument optics may affect visibility and reading precision.
4. **Weather Factors:** Wind or vibration can affect instrument stability, while rain can reduce EDM accuracy.

Proper planning, early-day fieldwork, tripod stabilization, and careful station positioning help address these challenges. Where obstructions occur, indirect observation techniques and offsets may be applied.

2.6.3 Limitations of Methodology

Although Total Station surveying is accurate and reliable, certain limitations are recognized in this study:

1. **Limited Spatial Coverage:** Unlike GNSS or drone surveys, Total Station methods require line-of-sight and cannot rapidly cover large areas.
2. **Time-Intensive Indoors:** Measuring interior room-to-room details requires several setups and careful point selection.
3. **Equipment Sensitivity:** Instrument accuracy depends on proper calibration and careful handling.
4. **Dependence on Prism Setup:** Some observations require a second operator to hold the prism, increasing manpower needs.

5. Potential for Human Error: Incorrect leveling, inaccurate prism centering, or poor referencing can distort final results.
6. No Real-Time Terrain Model: Unlike LiDAR or drone photogrammetry, terrain surfaces are manually interpolated from collected points.

Despite these limitations, Total Station surveying remains highly suitable for the scale and objectives of this project — providing precise coordinate measurements for perimeter definition, detailed topographic mapping, and accurate floor plan production.

2.7 Review of Relevant Literature

Didigwu and Olakanmi (2017) examined the role of cadastral survey information in supporting effective land administration in Nigeria. Their study, which covered different regions of the country, focused on issues such as boundary identification, land ownership rights, and mapping challenges. The authors reviewed existing cadastral survey information and analysed mapping practices to determine how spatial data are collected, stored, and utilised in land administration. The findings revealed that many cadastral maps currently in use in Nigeria were produced more than two decades ago and are therefore outdated and unreliable for present-day development activities. The study emphasized that the absence of up-to-date digital cadastral survey data significantly hinders efficient land administration and effective land management in Nigeria.

Similarly, Didigwu and Olakanmi (2016) investigated the importance of cadastral survey information in facilitating land administration in Nigeria. The researchers carried out a review of existing cadastral survey records, mapping practices and spatial information systems in the country, with particular attention to the status of digital cadastral databases. Their analysis showed that a large proportion of cadastral maps currently in use in Nigeria are outdated and have not been digitised. The study concluded that the development of an

up-to-date digital cadastral database is essential for improving land administration and ensuring effective management of land resources in Nigeria.

Sule (2000) investigated the challenges affecting cadastral surveying practice in Nigeria. The study focused on factors such as the increasing demand for cadastral surveys, inadequate resources and institutional limitations. Using descriptive statistical techniques, including frequencies and percentages, the author analysed responses obtained from practicing surveyors regarding the constraints affecting cadastral survey operations. The results indicated that the cadastral surveying system in Nigeria is under significant pressure due to increasing demand for land information, limited cadastral controls, financial constraints and institutional weaknesses, which collectively hinder effective cadastral service delivery.

Akinyemi (2016) discussed the digital map initiative for Nigeria's national topographic database and examined the progress made in the digitalisation of topographic maps in the country. The study reviewed the process of converting the analogue 1:50,000 topographic map series into digital format and analysed the institutional and technological challenges associated with the process. The author observed that most of the 1:50,000 topographic maps available in Nigeria were originally produced around 1966–1967 and have not been adequately updated. The study concluded that the digitalisation of these maps is long overdue and that major challenges such as inadequate funding, limited technological infrastructure and shortage of skilled personnel continue to delay the process.

Ufua (2003) examined the factors responsible for the non-revision of the 1:50,000 topographic map series in Nigeria and assessed the implications of this situation for sustainable development. The study utilised field surveys and interviews alongside the review of mapping and cartographic data. The findings revealed that the lack of map revision in Nigeria is largely due to inadequate manpower, obsolete surveying and mapping

equipment, outdated data sources and insufficient funding. The author further noted that reliance on outdated maps negatively affects planning and development activities and often leads to increased costs during project implementation.

Pepple, Bala, Aro-Lambo and Ibukun (2023) conducted a study aimed at revising the small-scale topographic map sheet 303 of Abakaliki South-West by comparing the 1966 map with more recent data from 2019. The study employed satellite imagery and ASTER Digital Elevation Model (DEM) data to analyse land use and land cover changes as well as variations in terrain elevation. Geographic Information System (GIS) techniques were used for data processing, classification and vectorisation. The results revealed significant expansion of built-up areas and road networks over time, as well as noticeable elevation changes attributed to activities such as landfill operations and sand mining. The study recommended regular revision of topographic maps using modern remote sensing technologies to ensure mapping accuracy.

Taiwo, Ibitoye and Oladejo (2024) compared conventional cadastral mapping methods with a fit-for-purpose approach using high-resolution aerial imagery in Ekiti State, Nigeria. The study involved the collection of spatial data using RTK GNSS, theodolite traversing and unmanned aerial vehicle (UAV) imagery. The researchers evaluated the accuracy, time efficiency and cost implications of each method using Root Mean Square Error (RMSE) analysis. The results showed that RTK GNSS was the fastest method for field data collection, while the theodolite traverse method was the slowest. The study also revealed that high-resolution aerial imagery obtained from UAV platforms can produce accuracy levels comparable to conventional surveying methods. However, the authors noted that regulatory and institutional frameworks in Nigeria have not yet fully adapted to the integration of UAV and aerial imagery technologies in cadastral mapping practices.

2.7.1 Synthesis and Identification of Research Gaps

The reviewed studies collectively emphasize the importance of accurate cadastral and perimeter surveys for land administration, planning, and development control. Researchers such as Aminigbo (2021) demonstrated the rigorous application of Total Station methods and third-order survey standards in producing precise boundary and detail maps. Similarly, (Didigwu *et al.*, 2016) and (Akinyemi 2016) highlighted the critical role of modern digital cadastral datasets in improving land management and the challenges posed by outdated survey maps in Nigeria. Comparative and technological studies, including (Taiwo *et al.*, 2024) and (Pepple *et al.*, 2023), underscored the growing relevance of digital tools UAVs, GNSS-RTK, DEMs, and GIS in enhancing mapping accuracy and efficiency. While these works vary in methodology and geographic focus, they share a consensus that modernization of surveying practices and spatial data infrastructure is essential for effective land governance in Nigeria.

Despite these contributions, notable gaps remain. First, much of the existing research focuses either on nationwide mapping strategies or broad digital cadastral modernization, with limited emphasis on practical perimeter and detail surveys for newly built structures within institutional environments, particularly Nigerian universities. Second, although some studies explore the comparison of conventional and modern instruments, there is insufficient documentation of application-level workflows using Total Station exclusively for small-area digital mapping in active campus development zones. Additionally, many studies acknowledge the need for current, ground-truth spatial information, yet empirical case studies within dynamic academic settings where rapid physical expansion is occurring are scarce.

This study addresses these gaps by conducting a detailed perimeter survey and digital mapping of newly built structures within the University of Benin, Ugbowo Campus, using

Total Station methods in line with professional geospatial standards. By producing updated spatial data, coordinates, floor plans, and a topographic representation of the study area, this research provides a practical demonstration of modern campus-scale surveying. The findings will support institutional planning, infrastructure management, and future spatial database development within the university environment, thereby contributing to the ongoing effort to modernize geospatial practice in Nigeria. (Kavanagh and Slattery, 2014).

CHAPTER THREE

METHODOLOGY

3.1 Description of Study Area



Figure 3.1: Aerial View of Study Area.

The study area is located within the University of Benin, Ugbowo Campus, Benin City, Edo State, Nigeria. The University of Benin is one of Nigeria's leading federal institutions of higher learning and occupies approximately 1,700 acres of land. The campus lies within the humid tropical rainforest belt of Southern Nigeria, experiencing a tropical climate with distinct wet and dry seasons. Average annual temperatures range from 26°C to 28°C, with rainfall occurring predominantly between April and October. Field data collection was conducted under favourable weather conditions to ensure high-quality observations and instrument performance.

The selected study area comprises a portion of the university's academic development zone containing three newly constructed buildings. These buildings were selected due to their recent completion and the need for accurate perimeter survey and digital mapping to support spatial documentation and campus planning. The site consists of paved walkways, campus access roads, landscaped surroundings, and functional drainage channels guiding surface runoff away from building foundations.

Topographically, the terrain is generally flat to gently undulating, providing a suitable environment for Total Station observations, instrument setup, and line-of-sight visibility. The ground surface is composed of paved and moderately compacted earth areas, ensuring stable tripod support and minimizing reading errors during fieldwork. Vegetation within the site consists mainly of grasses and ornamental plants, with minimal obstructions to survey sighting.

The area is easily accessible via internal campus roads and pedestrian routes, enabling safe movement of surveying personnel and equipment. The environment is secure and controlled, which reduced the risk of equipment interference and provided favourable working conditions. The study location is bordered by major surrounding communities including Ugbowo, Urelu, and Oluku. Geographically, the University of Benin lies approximately between latitude $6^{\circ}24'N$ and longitude $5^{\circ}36'E$.

The site was chosen based on accessibility, safety, suitability for Total Station operations, and institutional need for updated spatial data. The survey and resulting digital mapping contribute to proper documentation and campus development planning within the University of Benin.

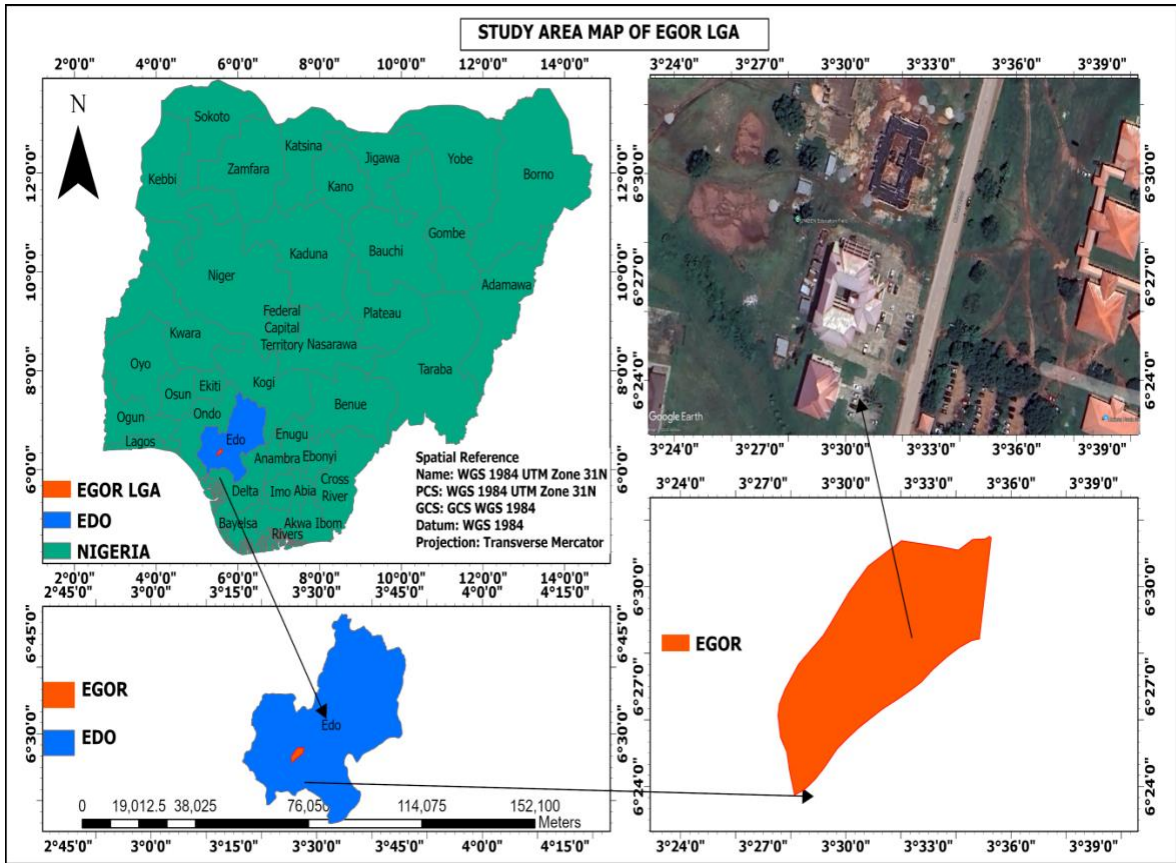


Figure 3.2: Study Area Map of Faculty of Environmental Science Complex

3.2 Research Design

This project adopted a field-based engineering survey approach, supported by digital mapping techniques. The design was structured to systematically obtain accurate ground measurements and building dimensions required for perimeter mapping, topographic representation, and floor plan production.

I employed the Total Station survey method, which combines angular and linear measurements to determine precise point coordinates. The approach began with a reconnaissance survey to assess the study area and identify suitable control stations. Following reconnaissance, the Total Station was set up on established campus control points to observe angles, distances, and elevations across the project area.

The research design also incorporated direct building measurement procedures, where key structural elements such as building corners, door and window points, and interior wall

lines were observed and recorded. This ensured accurate capture of both external and internal features of the selected buildings.

After field data acquisition, the collected observations were transferred to appropriate software for processing and adjustment. The design concluded with the digital drafting of the perimeter map, topographic map, and floor plans using CAD-based applications. The overall methodology reflects a practical execution framework that aligns with professional surveying standards and ensures reliability in mapping and spatial analysis.

3.3 Instruments and Equipment Used

In this project, the primary equipment used for data acquisition was the Total Station, supported by standard surveying accessories and computer-based mapping tools. The Total Station served as the main instrument for measuring horizontal and vertical angles, distances, and elevations required for perimeter mapping, topographic detail collection, and building measurement.

The equipment used included:

Total Station – The Total Station served as the primary instrument for field observations. It integrates an electronic distance measurement (EDM) unit with a theodolite and microprocessor, enabling accurate measurement of horizontal and vertical angles, slope distances, and automatic computation of coordinates. Its precision and versatility made it suitable for both perimeter boundary observations and detailed building measurements, including internal points for the floor plans.

Tripod Stand – A tripod stand is a three-legged support structure used to provide a stable and level base for mounting the Total Station during field observations. It ensures the instrument remains firmly fixed in position, preventing movement that could compromise measurement accuracy. The tripod legs can be adjusted and anchored securely into the ground, enabling firm positioning on uneven terrain. Proper tripod setup is essential for

accurate 26modelling, precise angle measurements, and maintaining instrument stability throughout the survey process.

Prism and Prism Pole – A prism is a precision-engineered reflective optical device used as a target for electronic distance measurement (EDM) by the Total Station. It functions by receiving the emitted electromagnetic signal from the instrument and returning it along the same path, allowing the Total Station to compute accurate slope distances. The prism ensures high-precision distance measurement, particularly over medium to long survey ranges.

The prism is mounted on a prism pole, a vertically adjustable rod designed to position the prism directly above survey control points or detail points. The prism pole contains height markings and a bubble level, enabling proper vertical alignment and accurate recording of prism height (HP) during measurement. Maintaining correct prism alignment ensures the reliability of point coordinates, especially when capturing building corners, structural points, and perimeter boundaries.

In this project, the prism and prism pole were essential for establishing survey control, conducting detailed measurement, and ensuring measurement accuracy during field observations.

Survey Field Book – A field book was used to record essential survey information such as station setups, instrument heights (HI), prism heights (HP), observed angles and distances, sketches, and field conditions. Proper documentation ensured traceability and facilitated accurate data processing and verification.

Measuring Tape – A measuring tape is a flexible graduated linear measuring tool used in this study as a supplementary device for obtaining short horizontal distances and internal room dimensions where instrument setup was not feasible. Although the Total Station provided precise angular and distance measurements, the tape served as a verification tool

for critical distances, especially within confined indoor spaces during floor plan acquisition.

It was also used for cross-checking control distances, ensuring data reliability and minimizing cumulative measurement error. The use of a measuring tape provided an additional layer of accuracy control and supported efficient detail extraction in situations requiring manual dimensioning.

Station Accessories – including plumb bob, tribrach, and battery packs to support accurate instrument setup and operation.

For data processing and map production, I used appropriate software including:

AutoCAD / Civil 3D

AutoCAD and AutoCAD Civil 3D were utilized in this project for spatial data processing, mapping, and plan production. After field observations were completed, coordinated survey points obtained from the Total Station were imported into AutoCAD for initial plotting and drafting. AutoCAD was used to generate the perimeter boundary layout. The software allowed precise dimensioning, annotation, and application of standard survey drafting conventions, thereby ensuring accuracy and professional presentation of the final drawings. Civil 3D was subsequently employed to process the elevation data collected during the topographic survey. The spot heights were imported to create a Digital Terrain Model (DTM), from which contour lines were generated to accurately represent the terrain within the study area. Civil 3D's surface modelling tools enabled effective terrain visualization and ensured that the resulting topographic map reflected true ground variations and natural landform patterns.

Together, AutoCAD and Civil 3D provided a comprehensive workflow for geometric drafting, surface modelling, and final cartographic output, ensuring that both the building plans and topographic map met standard surveying and engineering drawing requirements.

Microsoft Excel – for organizing raw observations, coordinate computation, and data formatting.

Data Transfer and Storage Devices – such as USB devices and laptop storage for secure transfer and backup of survey data.

The combination of these tools ensured reliable data acquisition in the field and accurate digital processing during map and floor plan production. All instruments were checked to ensure proper calibration and performance before and during field operations to maintain the integrity of the results obtained.

3.4 Data Acquisition Method

The data acquisition phase followed a systematic field procedure designed to ensure spatial accuracy, consistent measurements, and reliable output results. The process commenced with a reconnaissance survey to familiarize with the study area, identify suitable instrument stations, evaluate line-of-sight conditions, and plan the most efficient observation sequence. This preliminary inspection also involved determining accessible instrument setups that would enable adequate coverage of all building corners and site features. The Total Station was set up over these control stations, precisely centered and modelling. Instrument height (HI) and prism height (HP) were recorded for each setup to ensure proper coordinate reduction. The instrument was oriented using a backsight to a known reference point to establish direction control. A closed-traverse method was adopted to provide coordinate consistency and minimize angular and linear errors.

Field data collection proceeded with perimeter boundary observations, where angle and distance measurements were recorded to define the study boundary. Detail survey followed immediately, capturing ground points, spot heights, and all relevant physical features within the mapped area. Throughout the data acquisition process, repeat measurements and field checks were carried out to detect blunders and maintain accuracy. Field notes,

observation details, and sketches were documented in the field book, and digital data were stored and backed up after each field session. This structured data collection approach ensured accuracy, reliability, and completeness of the spatial data used for perimeter mapping, topographic analysis, and floor plan production.

3.5 Data Processing and Analysis

The data collected during the fieldwork underwent systematic processing to ensure accuracy and convert raw measurements into usable spatial information. The first stage involved downloading field observations from the Total Station into a compatible data format. All raw angle and distance measurements, as well as instrument and prism height records, were cross-checked with field notes to verify completeness and eliminate possible transcription errors.

3.5.1 Traverse Computation and Adjustment

The observed traverse data were entered into Microsoft Excel for computation. Angular misclosure and linear misclosure values were calculated to assess the consistency of field measurements. Any detected errors were minimized and distributed proportionally using the Bowditch (Compass) Rule to achieve a balanced traverse. This adjustment ensured the coordinate network formed a reliable control framework for subsequent mapping operations.

3.5.2 Coordinate Determination

Corrected angular and distance values were processed to compute the Eastings, Northings, and elevations of each survey station and detail point. Computed coordinates formed the basis for plotting the perimeter boundary, topographic points, and building corners. Spot heights collected during the survey were also processed to derive ground elevations for terrain 29modelling.

3.5.3 Digital Mapping and Drafting

Processed coordinates were imported into AutoCAD to generate the perimeter map and building floor plans. The software was used for; Plotting survey points and lines, Drawing building outlines and internal partitioning, Annotating dimensions and control information, Adding cartographic elements such as scale, north arrow, legends, and title block.

To produce the topographic map, elevation points were exported into Civil 3D, where a Digital Terrain Model (DTM) was generated. Contour lines and a 3D surface representation were developed to illustrate terrain variation within the study area. Editing tools were applied to refine surface anomalies and ensure smooth contour progression.

Quality Assurance

Quality checks were carried out throughout the processing stage. Duplicate measurements and reference distances were used to verify positional accuracy. Coordinate comparisons, on-field rechecks, and visual inspection of plotted drawings ensured adherence to professional survey standards.

This rigorous processing workflow converted raw observational data into accurate maps, topographic surfaces, and detailed building floor plans fit for academic and engineering usage.

3.6 Limitations of Methodology

Although this study achieved its objectives, certain limitations were encountered during the survey and data processing stages. The use of only a Total Station for data acquisition limited the speed of data collection when compared to a combined GNSS–Total Station workflow.

Environmental and physical constraints were also present. Movement around some parts of the site was restricted by building activities and pedestrian traffic, which occasionally slowed down prism alignment and measurement operations. In addition, weather conditions

such as heat and direct sunlight affected line-of-sight clarity at certain periods, requiring short breaks to maintain accuracy.

In terms of data processing, minor discrepancies were observed during field-to-office conversion, requiring additional checks and manual verification to ensure consistency. Despite these limitations, the adopted methodology still provided reliable and accurate results suitable for the production of the perimeter survey, topographic map. These limitations did not compromise the quality of results, and appropriate corrective procedures were applied where necessary.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Analysis of the Topographic Map

The topographic map provides a detailed representation of the elevation and physical features within the study area. Contour lines indicate changes in terrain elevation, showing the slope, flat areas, and any variation in height across the site. Spot elevations recorded during the survey were used to generate the contours, providing an accurate depiction of the land surface.

In addition to elevation, the topographic map highlights the location of significant features such as existing buildings, pathways, vegetation, and other structures observed during the field survey. These features are important for site planning, construction, and environmental assessment.

The map demonstrates the capability of digital mapping techniques to convert raw field measurements into a visual, understandable, and usable format. It also confirms the reliability of the Total Station in recording both horizontal and vertical positions, producing a comprehensive view of the terrain.

From the topographic map, one can analyze the slope direction, drainage patterns, and elevation distribution, which are essential for design, planning, and management of the study area. The map can also serve as a baseline for future surveying, development projects, or land use planning within the Ugbowo Campus.

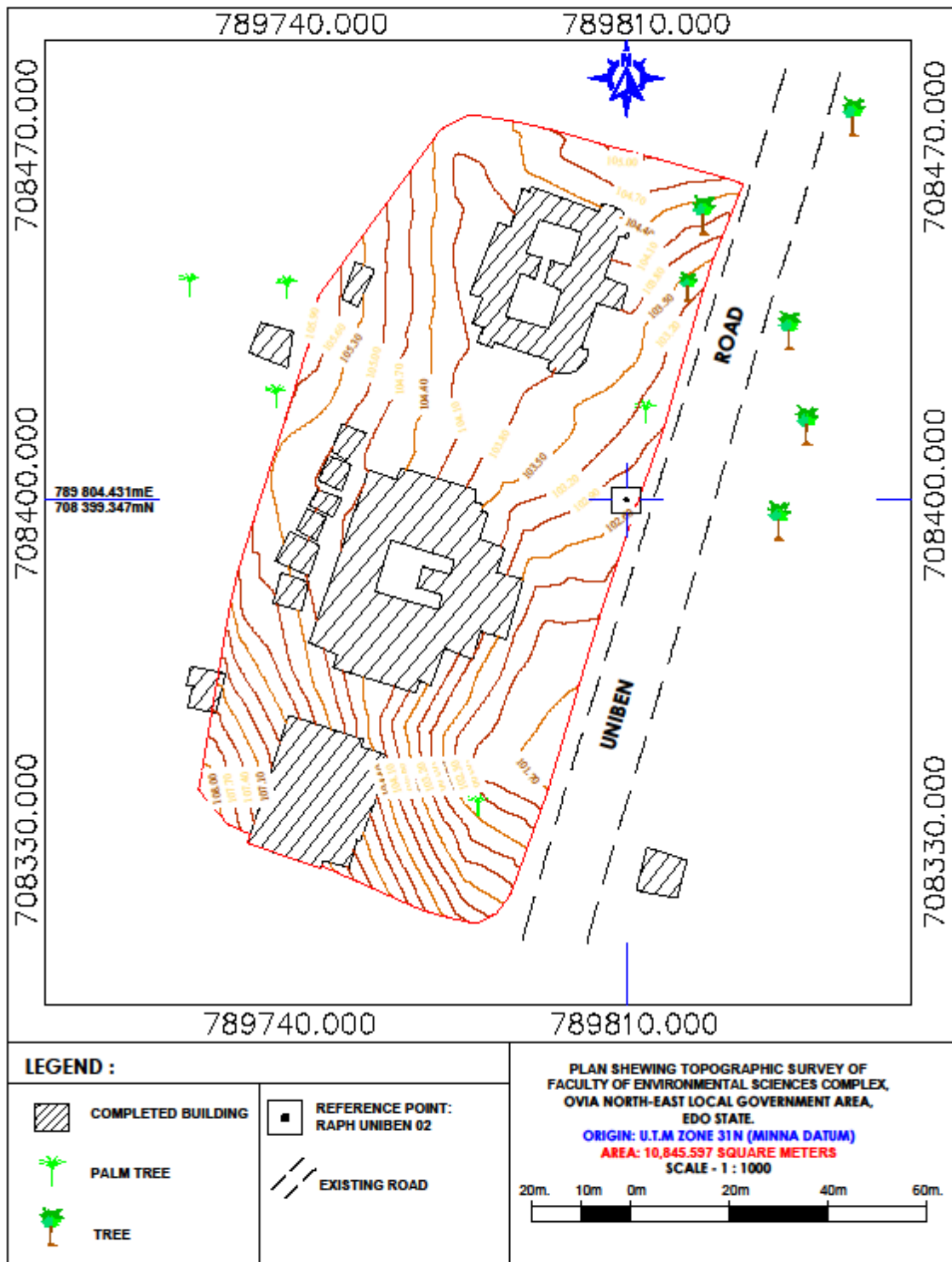


Figure 4.1 Topographic Map of Faculty of Environmental Sciences Complex.

4.2 Analysis of the Perimeter Map

The perimeter map illustrates the boundary of the study area as determined from the field survey using the Total Station. The coordinates of the boundary points were accurately measured and processed to define the limits of the site. The map shows the spatial layout and dimensions of the study area, highlighting the exact location of each corner point and the lines connecting them to form the perimeter.

The map serves as a visual confirmation of the land extent and can be used for planning, construction, and legal documentation purposes. From the perimeter map, it can be observed that the site boundary is clearly demarcated, with precise measurements that allow for accurate calculation of the total area and linear distances along the boundary.

The perimeter map demonstrates the effectiveness of using Total Station surveying equipment in capturing reliable positional data. The clarity and accuracy of the boundary lines indicate that the survey data were correctly processed and represented in a digital format suitable for professional use.

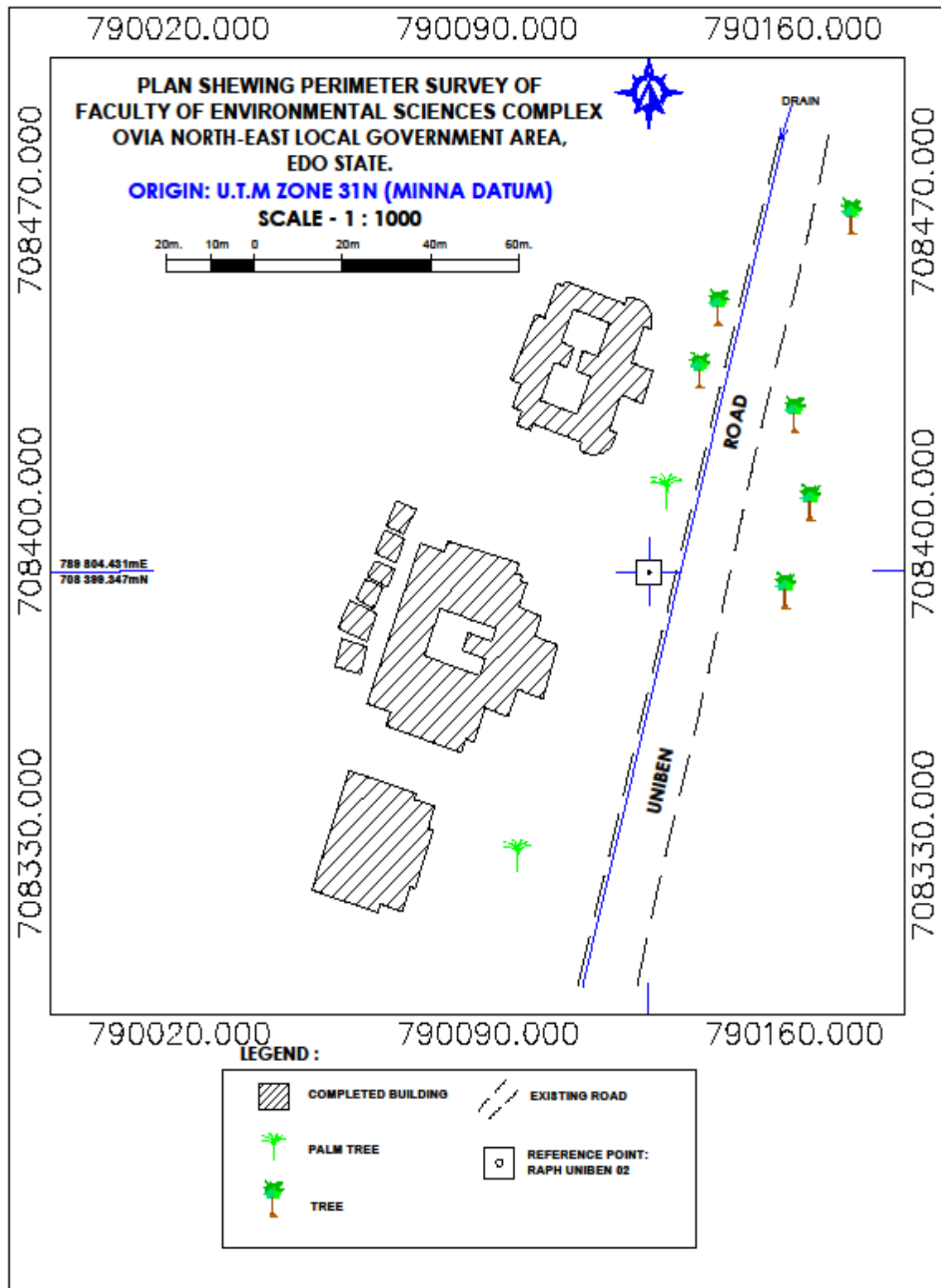


Figure 4.2 Digital Mapping of Faculty of Environmental Sciences Complex.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project focused on the perimeter survey and digital mapping of three newly built structures within the University of Benin, Ugbowo Campus. The primary objective was to acquire accurate boundary data, process the observations, and produce perimeter plans for the buildings using modern surveying techniques.

A Leica Total Station was used for data acquisition, and three separate building footprints were surveyed. The field observations consisted of horizontal distances, angles and derived coordinates. The data was exported and processed, then plotted in AutoCAD 2020 to generate precise perimeter maps for each building. The coordinate area method was applied manually to verify the area of one building, while the AutoCAD AREA command was used to compute the remaining two. The final results include clearly defined boundary layouts for all three buildings demonstrating the accuracy and efficiency of digital surveying workflows.

This perimeter survey successfully produced accurate digital plans for three newly constructed buildings in the Faculty of Environmental sciences complex using a Total Station and CAD software. The workflow applied enabled precise determination of coordinate positions and corresponding building extents.

The exercise demonstrated that Total Station-based perimeter surveys remain highly reliable for engineering and construction mapping tasks, particularly in constrained environments such as university facilities. The project also reinforced the importance of proper field procedures, coordinate management, and digital mapping techniques in modern surveying practice.

5.2 Recommendations

Based on the findings and experience gained, the following recommendations are made:

1. The University should periodically conduct digital surveys of buildings and infrastructure to maintain an updated spatial database.
2. Future projects should integrate GNSS and Total Station observations for improved efficiency and control.
3. Detailed topographic should be conducted to complement perimeter mapping for campus development.
4. Students undertaking similar projects should be exposed to both manual and software-based computation techniques to enhance technical confidence.

APPENDIX

S/N	EASTING	NORTHING	ELEVATION	DESCRIPTION
1	789828	708463	104.6	PT1
2	789826	708459	104.2	PT2
3	789824	708454	103.9	PT3
4	789822	708448	103.5	PT4
5	789820	708442	103.2	PT5
6	789818	708436	103	PT6
7	789816	708431	103	PT7
8	789815	708425	103	PT8
9	789813	708419	102.9	PT9
10	789812	708414	102.9	PT10
11	789810	708409	102.8	PT11
12	789808	708403	102.7	PT12
13	789805	708394	102.5	PT13
14	789802	708388	102.4	PT14
15	789799	708378	102.1	PT15
16	789795	708369	101.8	PT16
17	789792	708360	101.7	PT17
18	789789	708351	101.6	PT18
19	789786	708343	101.7	PT19
20	789783	708334	102.4	PT20
21	789781	708326	103	PT21
22	789778	708316	103.7	PT22
23	789824	708464	104.7	PT23
24	789822	708460	104.4	PT24
25	789820	708456	104.2	PT25
26	789819	708452	103.9	PT26
27	789817	708448	103.7	PT27
28	789815	708443	103.5	PT28
29	789813	708438	103.4	PT29
30	789811	708433	103.3	PT30
31	789809	708429	103.4	PT31
32	789807	708425	103.4	PT32
33	789805	708419	103.3	PT33
34	789803	708413	103.2	PT34
35	789803	708409	103.1	PT35
36	789802	708404	102.9	PT36
37	789801	708399	102.8	PT37

38	789798	708394	102.7	PT38
39	789796	708389	102.5	PT39
40	789796	708383	102.3	PT40
41	789800	708383	102.3	PT41
42	789793	708377	102.1	PT42
43	789790	708372	101.9	PT43
44	789788	708365	101.8	PT44
45	789786	708359	101.8	PT45
46	789783	708354	101.8	PT46
47	789783	708348	101.7	PT47
48	789780	708345	101.7	PT48
49	789781	708339	102.1	PT49
50	789778	708333	102.6	PT50
51	789777	708340	102.2	PT51
52	789786	708338	102	PT52
53	789776	708327	103.1	PT53
54	789777	708321	103.4	PT54
55	789774	708334	102.7	PT55
56	789783	708330	102.6	PT56
57	789772	708328	103.1	PT57
58	789774	708314	104	PT58
59	789781	708320	103.3	PT59
60	789770	708316	104.1	PT60
61	789772	708321	103.6	PT61
62	789769	708323	103.8	PT62
63	789765	708316	104.6	PT63
64	789762	708318	104.8	PT64
65	789766	708320	104.3	PT65
66	789763	708322	104.5	PT66
67	789766	708326	103.9	PT67
68	789758	708319	105.2	PT68
69	789760	708323	104.8	PT69
70	789769	708326	103.6	PT70
71	789779	708329	102.8	PT71
72	789775	708330	102.9	PT72
73	789762	708327	104.3	PT73
74	789766	708331	103.6	PT74
75	789819	708466	104.9	PT75
76	789813	708467	104.9	PT76
77	789815	708464	104.8	PT77
78	789817	708461	104.5	PT78
79	789815	708455	104.2	PT79
80	789809	708463	104.8	PT80
81	789808	708458	104.6	PT81

82	789811	708459	104.5	PT82
83	789813	708451	104.1	PT83
84	789808	708468	105	PT84
85	789803	708470	105.1	PT85
86	789804	708465	104.9	PT86
87	789798	708471	104.9	PT87
88	789799	708468	104.9	PT88
89	789812	708462	104.7	PT89
90	789792	708472	104.7	PT90
91	789794	708469	104.8	PT91
92	789787	708473	104.6	PT92
93	789789	708474	104.7	PT93
94	789788	708470	104.6	PT94
95	789783	708475	104.5	PT95
96	789783	708471	104.4	PT96
97	789783	708473	104.4	PT97
98	789780	708476	104.3	PT98
99	789780	708473	104.3	PT99
100	789779	708470	104.3	PT100
101	789781	708469	104.3	PT101
102	789773	708477	104.1	PT102
103	789808	708452	104.3	PT103
104	789741	708435	105.9	PT104
105	789746	708433	105.6	PT105
106	789751	708431	105.2	PT106
107	789756	708429	104.9	PT107
108	789760	708427	104.6	PT108
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112	789750	708434	105.3	PT112
113	789751	708436	105.3	PT113
114	789754	708432	105.1	PT114
115	789754	708435	105.1	PT115
116	789757	708431	104.9	PT116
117	789757	708434	104.9	PT117
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119	789760	708433	104.7	PT119
120	789763	708427	104.5	PT120
121	789763	708430	104.5	PT121
122	789763	708433	104.5	PT122
123	789767	708430	104.3	PT123
124	789770	708426	104.1	PT124
125	789775	708424	104	PT125

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133	789787	708414	103.6	PT133
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143	789766	708417	104.3	PT143
144	789788	708405	103.4	PT144
145	789777	708463	104.1	PT145
146	789775	708467	104.1	PT146
147	789774	708458	104	PT147
148	789773	708454	104	PT148
149	789771	708448	104	PT149
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198	789798	708373	101.9	PT198
199	789787	708378	102.1	PT199
200	789793	708386	102.4	PT200
201	789787	708369	101.9	PT201
202	789770	708342	102.5	PT202
203	789773	708344	102	PT203
204	789776	708349	101.9	PT204
205	789769	708349	102.4	PT205
206	789771	708351	102.2	PT206
207	789766	708346	102.8	PT207
208	789761	708341	103.7	PT208
209	789761	708335	104	PT209
210	789755	708327	105.1	PT210
211	789759	708349	103.7	PT211
212	789764	708353	103	PT212
213	789754	708352	104.2	PT213

214	789757	708354	103.8	PT214
215	789749	708355	104.8	PT215
216	789753	708356	104.3	PT216
217	789746	708358	105	PT217
218	789739	708359	105.7	PT218
219	789732	708362	106.2	PT219
220	789736	708363	105.8	PT220
221	789726	708370	106.3	PT221
222	789733	708370	105.8	PT222
223	789727	708376	105.9	PT223
224	789725	708382	106	PT224
225	789729	708380	105.7	PT225
226	789729	708386	105.7	PT226
227	789729	708389	105.6	PT227
228	789729	708393	105.6	PT228
229	789733	708391	105.4	PT229
230	789730	708398	105.5	PT230
231	789734	708396	105.3	PT231
232	789731	708401	105.4	PT232
233	789735	708400	105.2	PT233
234	789734	708406	105.2	PT234
235	789735	708411	105.3	PT235
236	789737	708416	105.4	PT236
237	789743	708417	105.3	PT237
238	789729	708346	107.2	PT238
239	789724	708334	107.9	PT239
240	789718	708341	108.3	PT240
241	789727	708339	107.5	PT241
242	789721	708347	107.9	PT242

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