A PROJECT

ON

COMPARATIVE EVALUATION OF ACCURACY AND RELIABILITYOF DIGITAL LEVELLING AND TOTAL STATION EQUIPMENT TO DETERMINE THE HEIGHT MEASUREMENT

(*A CASE STUDY OF PART OF KWARA STATE POLYTECHNIC*)

BY

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SUBMITTED TO
DEPARTMENT OF SURVEYING AND GEO-INFORMATIC, INSTITUTE OF ENVIRONMENTAL STUDIES (I.E.S), KWARA STATE POLYTECHNIC, ILORIN.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE HIGHER NATIONAL DIPLOMA (HND) IN SURVEYING AND GEO-INFORMATIC.

JULY, 2025.

DECLARATION

I hereby certified that all the information given in this project were obtained as a result of observations and measurements made by me and that the survey was carried out in accordance with Survey Rules, Regulations and Departmental instructions.

NAME: GANIYU AKEEM ABIODUN

MATRICNO.:HND/23/SGI/FT/0076

SIGNATURE: ………………………………….

DATE OF COMPLETION: ……………………………………………….

CERTIFICATION

This is to certify that **GANIYU AKEEM ABIODUN** with matriculation number **HND/23/SGI/FT/0076**has satisfactorily carried out this project under our instructions and direct supervision.

SURV. A. G. AREMU ________________________

(PROJECT SUPERVISOR) *SIGNATURE AND DATE*

SURV. AWOLEYE R. S ________________________

(PROJECT COODINATOR) *SIGNATURE AND DATE*

MR. ABIMBOLA I. ISAU ________________________

(HEAD OF DEPARTMENT) *SIGNATURE AND DATE*

________________________ ________________________

EXTERNAL MODERATOR *SIGNATURE AND DATE*

DEDICATION

I dedicate this project to Almighty God, whose guidance, strength, and blessings have been my constant source of inspiration and perseverance.

ACKNOWLEDGEMENTS

First and foremost, my profound gratitude goes to the Almighty God who saw me through this program. Human endeavors cannot be a success without the help of Almighty God in heaven who made this project a success from the beginning to the end.

My profound gratitude goes to my wonderful supervisor in person of Surv. A.G. AREMU for his professional advices and supervision on the execution of my project, giving me all the necessary corrections where needed and appropriate. God bless you Sir.

My sincere gratitude also goes to My (H.O.D) MR. ABIMBOLA ISAU and other lecturers at the Department of Surveying Geo-informatics (SUR. A.G AREMU, SUR. R.S ASONIBARE, SUR. R.O AWOLEYE, SUR. BANJI, SUR. AYUBA, SUR. DIRAN, SUR. KAZEEM, SUR. KABIRU), for nurturing me in my academic activities. May Almighty Allah continue to bless you all abundantly.

I am immensely grateful to my parent, Mr. and Mrs. Ganiyu, for their invaluable advice and unwavering financial support throughout my schooling. I also extend my heartfelt appreciation to my Brother (Ridwan) for his encouragement and assistance, and to my Soulmate, (Aisha) for always remembering me in her prayers with advice.

My unreserved appreciation goes to my Group member for there support and there cooperation throughout our project research.

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ABSTRACT

The project compared and analyzed the data obtained using Total Station (TS) and level instruments in height measurement. To achieved the objective of the project, the perimeter boundary was determined using total station, and 20 points were established on the ground randomly with in the perimeter, and their X,Y,Z coordinates were determined using total station. The heights of the same points were determined as well using level instrument through the process of leveling and computations. The data obtained using the two instruments were saved in Microsoft excel and were imported in to AutoCAD for further processing in other to produce perimeter and detailed plans, as well to generate contour map of the project area. Based on descriptive statistics, it was found that the total station gave a minimum height of and 354.268m and a maximum of 356.736m, while digital Level gave a minimum height of 354.208m and a maximum of 356.680m, this indicates that both instruments gave a very close results hence both total station and digital level can be used in carrying out levelling for generating a height measurement. However, the time expenditure on each method revealed that the total station is faster than using digital level for height measurement. The main advantage of total station compared to a digital level is therefore the total station is faster in data capture, shorter time and safer means of data processing and the ability of data storage and retrieval electronically, and the telescope can be tilted to sight a point which the spirit level lacks.

CHAPTER 1

1.0 INTRODUCTION

1.1 Background to the Study

Height determination is an essential aspect of surveying that involves determining the vertical location of a point relative to a reference datum. Surveyors typically use different techniques to determine the elevation of a point, including trigonometric levelling, barometric levelling, and spirit levelling (Simbolon et al., 2017).

Levelling is a widely used method for determining the elevations of ground points relative to a reference datum. It involves measuring the vertical distance between the ground point and the reference datum to obtain what is known as the reduced level. This is an important procedure that is used in various fields such as mapping, engineering design, construction, and setting out. The reference datum used in levelling is usually the mean sea level, which is assumed to be an equipotential surface. This means that points on this surface have the same gravitational potential energy. As such, the mean sea level is adopted as the reference surface for vertical control surveys (Schofield & Breach, 2007; Uren & Price, 2010).

1.1.1 Leveling

Schofield and Breach (2007) opined that levelling is a technique used to determine the vertical location of a point on or beneath the surface of the earth relative to a reference datum, while planimetry refers to the horizontal position of a point relative to a coordinate system. The authors also noted that these two procedures are separate and distinct, as each involves different equipment, procedures, and techniques. This idea is further supported by Ghilani and

Wolf (2014), who stated that levelling is primarily concerned with determining the elevations of ground points, whereas planimetry is focused on determining the position of those points in a horizontal plane. The choice of height system is critical in many applications, especially those that require accurate determination of elevation. For instance, in civil engineering projects such as road construction, it is important to know the elevation of the terrain to design the road profile, drainage, and culverts. The orthometric height system is widely used in such projects as it provides a meaningful height reference that is directly linked to the earth's gravity field.

However, other height systems, such as the ellipsoidal height system, are used in different applications. The ellipsoidal height system is based on the normal to the reference ellipsoid and is commonly used in satellite positioning systems such as GPS. The choice of height system depends on the application, and it is important to understand the differences between them to avoid errors in height determination (Torge, 2001).

Orthometric heights are determined by measuring the vertical distance between the point of interest and the geoid. This can be achieved through traditional techniques such as spirit levelling, trigonometric levelling, and GPS measurements (Odumosu et al., 2018). In spirit levelling, a series of measurements are taken with a level instrument, and the heights are computed based on the height of the instrument and the readings taken at the different locations. Trigonometric levelling involves measuring the angles and distances between two points and computing the height difference between them using trigonometric functions. GPS measurements use satellite signals to determine the height of a point above the ellipsoid and geoid is computed with high accuracy (Ghilani & Wolf, 2014).

The process of levelling involves using a levelling instrument to measure the vertical distance between the ground point and the reference datum. The levelling instrument consists of a spirit level and a graduated staff. The spirit level is used to ensure that the staff is held vertically, while the graduated staff is marked with a series of divisions that enable the observer to measure the vertical distance between the ground point and the reference datum. There are several methods for leveling observations in modern days, they include geometric leveling and trigonometric leveling methods (Lee & Rho, 2021). The choice of method to use largely depends on the accuracy desired, nature of the work to do and the availability of instrument to use.

1. 1.2 Total Station

The total station is a surveying instrument that combines the angle measuring capabilities of theodolite with an electronic distance measurement (EDM) and processing capabilities to calculate and determine horizontal angle, vertical angle and slope distance to the particular point.

The determination of the coordinates for an unknown point in relation to a known coordinate is achievable through the utilization of a total station, provided that a direct line of sight can be established between the two points (Putra et al., 2023). The process involves measuring angles and distances from the total station to the points under survey. Subsequently, trigonometry and triangulation are employed to calculate the coordinates (X, Y, and Z or northing, easting, and elevation) of surveyed points concerning the position of the total station. To get data on the distance of a point, the Total Station emits a wave, then the object will reflect the wave and be received back by the tool. Then the software inside the tool will automatically calculate the distance from where the tool stands to the measured point. To determine an absolute location, a total station requires line of sight observations and must be set up over a known point or with line of sight to two or more points with known location (Solomon, 2014).

1.2 Statement of the Problem

There is a need to evaluate the accuracy and reliability of digital leveling and total station equipment for height measurement, in order to determine which instrument is more suitable for specific applications.

1.3 Aim of the Project

The primary aim of this project is to compare the accuracy and reliability of digital leveling and total station equipment in determining height measurements.

1.4 Objectives

1. To evaluate the accuracy of digital leveling and total station equipment in measuring heights.
2. To assess the reliability of digital leveling and total station equipment in measuring heights.
3. To compare the performance of digital leveling and total station equipment in different environmental conditions.
4. To determine the suitability of digital leveling and total station equipment for various applications.

1.5 Scope of the Project

This project will focus on comparative evaluation of accuracy and reliability of digital levelling and total station equipment to determine the height measurement. The comparison will involve assessing the consistency of height readings, identifying sources of error, and determining the efficiency of each method in height determination.

1.6 Project Justification

This project is justified for the following reasons:

1. Improving Accuracy and Reliability: The project aims to evaluate the accuracy and reliability of digital leveling and total station equipment, which will help to identify the most accurate and reliable instrument for height measurement for different applications.
2. Reducing Errors: By identifying the most accurate and reliable instrument, the project will help to reduce errors in height measurement, which can have significant consequences in various fields.
3. Increasing Efficiency: The project will help to increase efficiency in surveying, engineering, and construction by providing a comprehensive evaluation of the accuracy and reliability of digital leveling and total station equipment.
4. Cost Savings: By identifying the most accurate and reliable instrument, the project will help to reduce costs associated with inaccurate height measurements and the need for rework.

5. Contribution to Knowledge: The project will contribute to the existing knowledge on the accuracy and reliability of digital leveling and total station equipment, which will be useful for researchers, surveyors, engineers, and construction professionals.

1.7 Significance of the Project

Understanding the differences between height measurements obtained from a total station and leveling instrument is crucial for surveyors, engineers, and researchers involved in topographic mapping and elevation studies. By comparing the performance of these two methods, this project aims to provide valuable insights into the strengths and limitations of each technique, helping professionals make informed decisions in choosing the most suitable method for their specific surveying tasks.

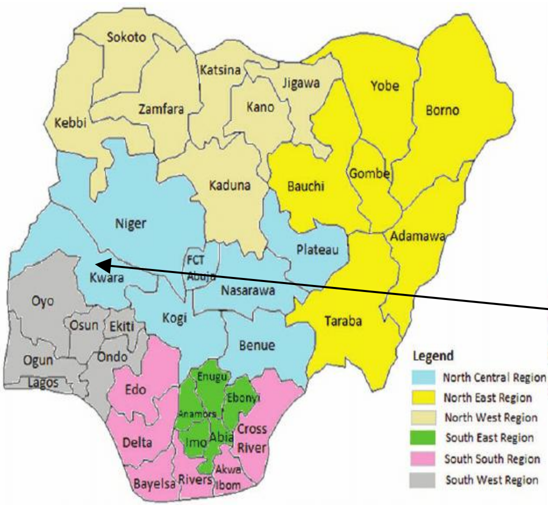
1.8 Personnel

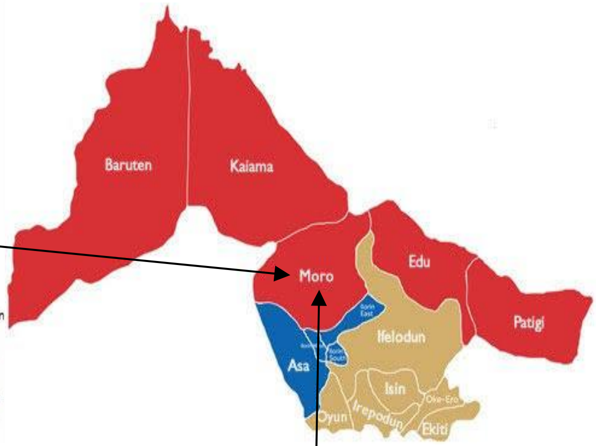
The project was assigned to and was successfully carried by the personnel listed below;

NAME	MATRIC. NO.	
Ganiyu Akeem Abiodun	HND/23/SGI/FT/0076	Writer
Abdul Kareem Ramota Olawumi	HND/23/SGI/FT/0078	Member
Kazeem Kabirat Damilola	HND/23/SGI/FT/0079	Member
Adeoti Qudus Adebayo	HND/23/SGI/FT/0080	Member
Adeleye Sheriffdeen Olawale	HND/23/SGI/FT/0081	Member
Abdul Qudus Shukurah Temitope	HND/23/SGI/FT/0083	Member
Ogunsuyi Babatunde Sunday	HND/23/SGI/FT/0118	Member
Jimoh Halimah Titilayo	HND/22/SGI/FT/082	Member

1.9 Project Location

The project site is located inside Kwara state polytechnic Ilorin, Kwara state.

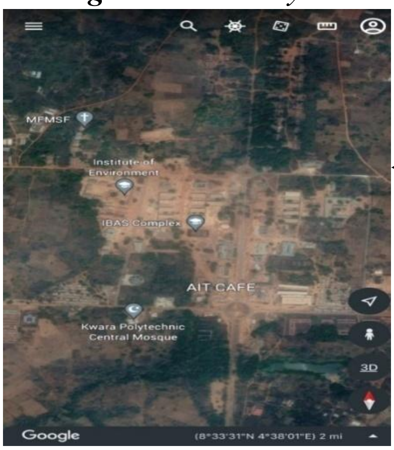




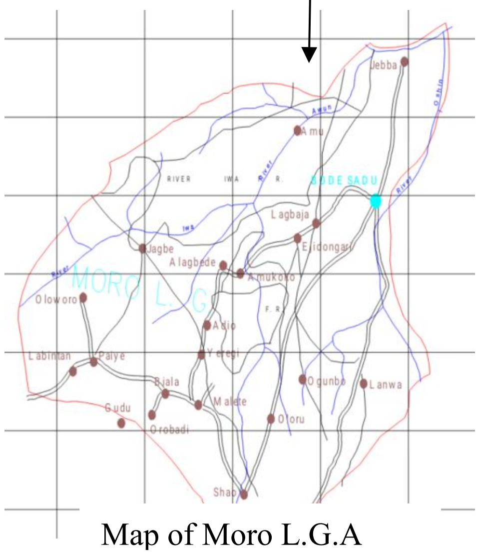
`` Map of Nigeria

Map of Kwara State

Figure 1.10*: Study Area Map*



Google Imagery of the Study Area



Map of Moro L.G.A

CHAPTER 2

2.0 LITERATURE REVIEW

Height determination is an essential aspect of surveying that involves determining the vertical location of a point relative to a reference datum. Surveyors typically use different techniques to determine the elevation of a point, including trigonometric levelling, barometric levelling, and spirit levelling (Simbolon et al., 2017). Levelling is a widely used method for determining the elevations of ground points relative to a reference datum. It involves measuring the vertical distance between the ground point and the reference datum to obtain what is known as the reduced level. This is an important procedure that is used in various fields such as mapping, engineering design, construction, and setting out. The reference datum used in levelling is usually the mean sea level, which is assumed to be an equipotential surface. This means that points on this surface have the same gravitational potential energy. As such, the mean sea level is adopted as the reference surface for vertical control surveys (Schofield & Breach, 2007; Uren & Price, 2010). The total station is a surveying instrument that combines the angle measuring capabilities of theodolite with an electronic distance measurement (EDM) and processing capabilities to calculate and determine horizontal angle, vertical angle and slope distance to the particular point (Lin, 2014). The determination of the coordinates for an unknown point in relation to a known coordinate is achievable through the utilization of a total station, provided that a direct line of sight can be established between the two points (Putra et al., 2023). The process involves measuring angles and distances from the total station to the points under survey. Subsequently, trigonometry and triangulation are employed to calculate the coordinates (X, Y, and Z or northing, easting, and elevation) of surveyed points concerning the position of the total station (Reyes, 2021). To get data on the distance of a point, the Total Station emits a wave, then the object will reflect the wave and be received back by the tool. Then the software inside the tool will automatically calculate the distance from where the tool stands to the measured point. To determine an absolute location, a total station requires line of sight observations and must be set up over a known point or with line of sight to two or more points with known location (Solomon, 2014).

Leveling is the general term, which applied to any of the various processes by which elevations of points or differences in elevation are determined. It is a vital operation in producing necessary data for engineering design, mapping, and construction. Leveling results usually used to:

1. Design highways, railroads, canals, sewers, water supply systems, and other facilities having grade lines that best conform to existing topography;
2. Lay out construction projects according to planned elevations;
3. Calculate volumes of earthwork and other materials;
4. Investigate drainage characteristics of an area
5. Develop maps showing general ground configurations;
6. Study earth subsidence and crustal motion.

Leveling is the measurement of geodetic height using an optical leveling instrument and a level staff or rod having a numbered scale. Common levelling instruments include the spirit level, the dumpy level, the digital level, and the laser level. Total station instruments can accomplish all of the tasks that could be done with transits and theodolites and do them much more efficiently. In addition, they can also observe distances accurately and quickly.

Furthermore, they can make computations with the angle and distance observations, and display the results in real time. These and many other significant advantages have made total stations the predominant instruments used in surveying practice today. These instruments are usually use for all types of surveys including topographic, hydrographic, cadastral, and construction surveys.

Previous studies have investigated the accuracy and reliability of digital leveling and total station equipment. For example, a study by (Awwad & Shaker, 2013) compared the accuracy of digital leveling and total station equipment and found that total station equipment exhibited higher accuracy. Another study by (El-Sheimy& Schwarz, 2010) evaluated the reliability of digital leveling equipment and found that it was affected by various factors, including instrument calibration and operator training.

Other studies have also investigated the factors that affect the accuracy and reliability of digital leveling and total station equipment. For example, a study by (Kang & Kim, 2015) found that the accuracy of total station equipment was affected by the quality of the instrument and the skill level of the operator. Another study by (Li & Wang, 2017) found that the reliability of digital leveling equipment was affected by the frequency of instrument calibration and the type of leveling rod used.

Furthermore, researchers have also explored the application of digital leveling and total station equipment in various fields. For example, a study by (Tao & Li, 2018) investigated the use of digital leveling equipment in monitoring the settlement of buildings.

Another study by (Kim & Kang, 2019) evaluated the use of total station equipment in surveying large-scale construction projects.

Additionally, studies have also investigated the impact of environmental conditions on the accuracy and reliability of digital leveling and total station equipment. For example, a study by (Schwarz & El-Sheimy, 2011) found that temperature and humidity affected the accuracy of digital leveling equipment. Another study by (Kavanagh & Bird, 2017) found that weather conditions affected the reliability of total station equipment.

Height measurement is a critical component of various fields, including surveying, engineering, and construction. With the advancement of technology, various instruments have been developed to measure heights accurately and efficiently. Two such instruments are Digital Leveling instruments and Total stations. This chapter reviews the existing literature on the comparison of height measurement using Digital Leveling instruments and Total stations.

2.1 Digital Leveling Instruments

Leveling instruments are used to measure the difference in height between two or more points on the Earth's surface. These instruments are essential tools in surveying, engineering, and construction for determining the elevation of points, establishing reference levels, and monitoring changes in the terrain.

The earliest leveling instruments were developed in the 17th century, with the introduction of the "dumpy level" (Schwarz, 2003). This instrument used a telescope and a spirit level to measure the difference in height between two points. Over the years, leveling instruments have evolved to include digital levels, laser levels, and total stations.

Digital Leveling instruments are electronic devices that use sensors and algorithms to measure the angle of elevation and calculate the height difference between two points (El-Sheimy, 2004). They are widely used in surveying, engineering, and construction due to their high accuracy, ease of use, and compact design

2.2 Total Station Instrument

Total stations are electronic instruments that combine the functions of a theodolite and an electronic distance measurement (EDM) device (Schwarz, 2003). They are widely used in surveying, engineering, and construction due to their high accuracy, versatility, and ability to measure distances and angles.

The first Total Station was introduced in the 1970s, with the development of electronic distance measurement (EDM) technology (Schwarz, 2003). Since then, Total Station has evolved to include advanced features, such as GPS integration, robotic measurement, and 3D scanning.

2.2.1 Components of Total Station

Total Station consists of several components, including:

1. Telescope: A magnifying device used to observe the target.

2. EDM: An electronic distance measurement device used to measure distances.

3. Theodolite: A device used to measure angles.

4. Processor: A computer used to process the measurements and calculate the results.

5. Display: A screen used to display the results.

2.3 Comparison of Height Measurement Capabilities

Several studies have compared the height measurement capabilities of Digital Leveling instruments and Total stations. A study by Kang (2015) found that Total stations were more accurate than Digital Leveling instruments in measuring heights, with a mean error of 1.3 mm compared to 2.5 mm for Digital Leveling instruments.

2.3.1 Factors Affecting Height Measurement Accuracy

Several factors can affect the accuracy of height measurements using Digital Leveling instruments and Total stations. These include:

1. Instrument calibration and maintenance (Schwarz, 2003)
2. Environmental conditions, such as temperature and humidity (El-Sheimy, 2004)
3. Operator error and training (Kang, 2015)
4. Quality of the instrument and its components (Schwarz, 2003)

2.3.2 Advantages and Limitations

Digital Leveling instruments and Total stations have several advantages and limitations.

The advantages of Digital Leveling instruments include:

- High accuracy and reliability
- Ease of use and compact design
- Fast and efficient measurement

The limitations of Digital Leveling instruments include:

- Limited range and accuracy in certain environmental conditions
- Requires calibration and maintenance

The advantages of Total stations include:

- High accuracy and versatility
- Ability to measure distances and angles
- Wide range of applications

The limitations of Total stations include:

- Higher cost compared to Digital Leveling instruments
- Requires more training and expertise to operate

2.4 Literature Review on Comparison of Total Station and Levelling Instrument in Height Measurement

Digital leveling is considered one of the most precise methods for height determination. It employs an electronic level instrument and a bar-coded staff to measure vertical distances, reducing human errors common in conventional leveling (Wolf & Ghilani, 2012). The technology ensures high precision by minimizing reading errors, making it ideal for precise engineering projects such as dam construction, bridge alignment, and geodetic surveys. However, digital leveling can be time-consuming and less efficient over long distances, which limits its use in large-scale projects (Kavanagh, 2014).

Total stations integrate electronic distance measurement (EDM) and angular measurement capabilities, allowing surveyors to determine both horizontal and vertical positions efficiently. Unlike digital levels, total stations are multifunctional, supporting a range of applications from topographic mapping to construction staking (Schofield & Breach, 2007). However, the accuracy of height measurement using total stations is influenced by factors such as instrument calibration, target reflectivity, and atmospheric conditions, leading to potential errors in elevation determination (Ghilani, 2017).

Comparative studies also reveal differences in the application of these instruments in different terrains. Researchers such as Uren & Price (2010) argue that levelling instruments are best suited for flat or gently sloping terrain, where accurate benchmark elevations can be established. Total stations, on the other hand, perform better in rugged and mountainous areas, where direct levelling may be difficult or impractical.

In terms of cost analysis, various scholars have pointed out that levelling instruments are generally more affordable than total stations. Kavanagh & Bird (2009) mention that traditional levelling instruments have a lower initial cost, making them a cost-effective solution for small projects. However, the time-consuming nature of levelling surveys may offset this cost advantage in large-scale projects, where total stations provide a quicker alternative.

A study by Ghilani& Wolf (2017) compared the reliability of height measurements from both instruments and found that while levelling instruments consistently produced highly accurate results, total stations exhibited minor variations due to EDM-related errors. However, advancements in total station technology, such as improved angular encoders and compensators, have significantly enhanced their accuracy in height determination.

The effect of atmospheric conditions on measurement accuracy has been widely studied. Hofmann-Wellenhof et al. (2008) explain that total stations require careful consideration of temperature, pressure, and humidity adjustments to minimize EDM errors. Levelling instruments, being optically based, are less sensitive to these factors, making them more reliable in extreme weather conditions.

Scholars also examine the role of error correction techniques in height determination. Uren & Price (2010) highlight that both instruments require regular calibration and error checks to ensure accuracy. Total stations need periodic adjustments to their EDM units and angular measurement systems, while levelling instruments must be checked for collimation errors and bubble alignment.

2.5 Project Review

In conclusion, both Digital Leveling instruments and Total stations are capable of accurate height measurements. However, Total stations are generally more accurate and versatile than Digital Leveling instruments. The accuracy of height measurements using both instruments can be affected by various factors, including instrument calibration and maintenance, environmental conditions, operator error and training, and quality of the instrument and its components.

CHAPTER THREE

3.0 METHODOLOGY

Methodology is the systematic theoretical analysis of the methods applied to a field of study, it comprises the theoretical analysis of the body of methods and principles associated with a branch of knowledge. Typically, it encompasses concepts such as paradigm, theoretical model, phases and quantitative or qualitative techniques.

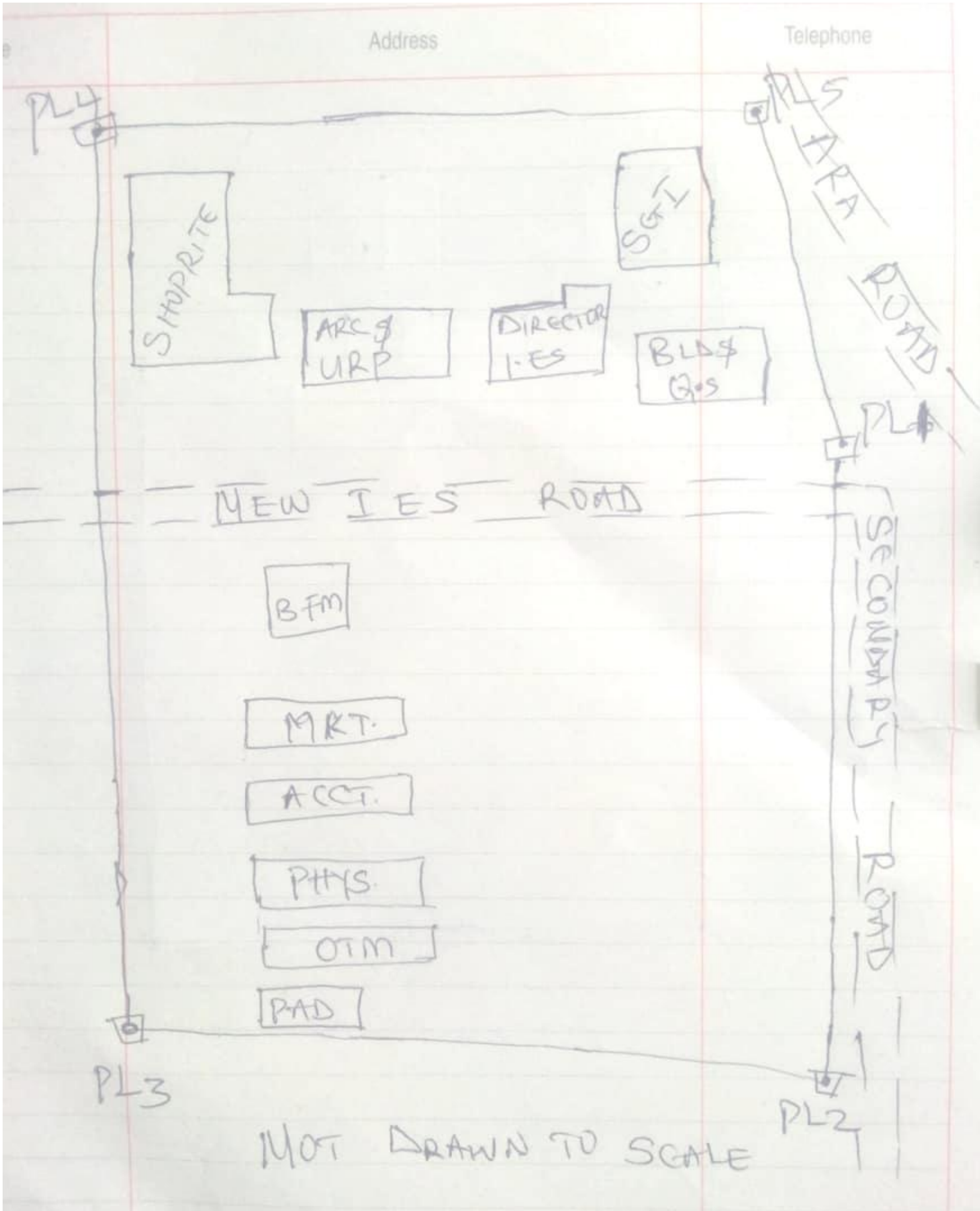
3.1 Reconnaissance

This has to do with framework of survey operation whereby all survey operations are going to base on.

Reconnaissance is also known as (Recce). Reconnaissance is examination of all part of an area accomplished insufficient detail to make generalization about the type and distribution of historical properties that may be present with a given project area. Also, is the process of having the general overview of the area to be surveyed with the view of determining the arrangement of the work such as method to employed, personnel to be involved, instrument to be used, scale at which plan/map is to be drawn. There are two stages of reconnaissance namely: Office and Field reconnaissance.

3.1.1 Field Reconnaissance

The first stage in this project was search for existing information in connection with the area in which the project was undertaken. Rough sketch diagram(recce) of the project area was drawn selecting and marking the approximate position of each point. To sum up, the reconnaissance facilitated the planning and execution of the actual survey as its takes into consideration, the possible problems that are likely to be encountered, and how such problems can be overcome or reduced to minimum.



Recce diagram

3.1.2 Office Reconnaissance

Office reconnaissance/data gathering as the name implies is the exploratory survey, scouting or examination, to collect information necessary for the successful execution of the project. It can be simply define as making a preliminary survey before the actual mobilization for the project site. For the purpose of this project, the data search involved retrieving of the coordinate of three (3) existing control.

Pillar No.	Easting(m)	Northing(m)	Height	Location
KWPT 49	674341.289	937679.115	353.682	Kwara Polytechnic
KWPT 50	674555.841	937618.402	354.903	Kwara Polytechnic

Table 1: *Show coordinates of existing and used control point.*

3.1.3 Selection of Station

The boundaries as shown in the recce diagram were laid down by marking points on the ground (station).

The factors considered in selecting these stations include:

1. Inter visibility between two points.
2. Firmness of the ground at the selected point.
3. Working convenience over the station.

4. Points located where not disturbed.

3.2 Survey Rod

A survey rod is a physical marker, typically made of metal, used to mark the boundaries of a parcel of land. These markers are used to define the limits of a property and can be used as reference points for future surveys. Rods are durable and can be used in a variety of environments.

3.2.1 Survey rules guiding rod uses:

1. Placement: Rods should be placed at boundary corners or points of change in the boundary.

2. Visibility: Rods should be visible and easily identifiable

3. Durability: Rods should be durable and resistant to weathering.

4. Accuracy: Rods should be placed accurately, following the surveyed boundary.

5. Documentation: the location and description of rods or pegs should be documented in the survey records.

Figure 3.1*: Graphical View of Cadastral Survey Rod*

3.3 Instrumentation

It refers to the equipment and accessories employed for the successful execution of this project and they are as follows:

Hardware Used

- Stonex R2 Plus Total Station and its accessories
- Leica Digital Level instrument and its accessories
- Handheld GPS

- Hp Core i5 vPro 8th Gen Laptop
- Cutlasses
- Head-pan
- Nail and bottle cover
- 1 Hammer
- 1 Spade
- 1 Hand-trowel

Software Used

- AutoCAD 2007
- Golden Software Surfer 20.0
- Microsoft Office Excel 2013
- Microsoft Office Word 2013

Material Used

- Water
- Cement

Total Station:- It is an electronic or optical instrument used in modern surveying and building construction that used Electronic Distance Measurement (EDM). It is also known as electronic data collection and storage system of which all the data acquired on site is been stored and secured for office reconnaissance.

Digital Leveling:- It is considered one of the most precise methods for height determination. It employs an electronic level instrument and a bar-coded staff to measure vertical distances, reducing human errors common in conventional leveling.

Table 3.2: *Equipment Description*

S/N	**Equipment**	**Uses**
1	Stonex R2 Plus Total Station	X, Y and Z coordinates of boundaries
2	Leica Automatic Level	Determination of the reduced level
3	Handheld GPS	X & Y coordinates of details
4	Autodesk AutoCAD 2007	Presentation of the boundaries
5	Golden Software Surfer 20.0	Contour and Generation of 3D model
6	Microsoft Office Excel 2013	X, Y and Y coordinates editing&program
7	Microsoft Office Word 2013	Report writing

3.4 Test of Instrument

For any survey job, testing of the instrument must be done before execution of the job, the instruments used for data acquisition were tested to ascertain whether they are in good working condition.

The following test were carried out,

3.4.1 Total Station

The total station instrument used (Stonex R2 Plus Total Station) underwent a two-phase check. Firstly, the vertical and horizontal angles were verified using pre-established control points within the school campus. Secondly, the electronic distance measurement (EDM) capability was tested for horizontal distances. The instrument passed all tests and was deemed suitable for use.

Below is the procedure for carryout the tests

3.4.1 Total Station

Instrument used in data acquisition was checked for integrity before moving them to site. Apart from check carried-out on Total Station, the following instruments were also checked: Tripod stand legs and their screw were confirmed okay, foot screws, focusing knob, vertical and horizontal knob for slow motion and clamp were all confirmed okay.

3.4.1.1 Horizontal Collimation Test

This error exists when the optical axis of the total station is not exactly perpendicular to the telescope axis. To test for horizontal collimation error, station A was selected and the instrument was set on it and leveled using three foot screws. Then, the telescope was rotated through 360°, but the bubble did not run out of the level tube centre which shows that the line of sight is parallel to the axis of the level tube.

Furthermore, the telescope was pointed to a target on station B in face left, then, pointed back to same target in face right; the difference in horizontal circle readings after averaging the result from both faces of the instrument was 180° except small variation is seconds which is permissible based on the allowable accuracy limit (least Count). The following results were displayed below.

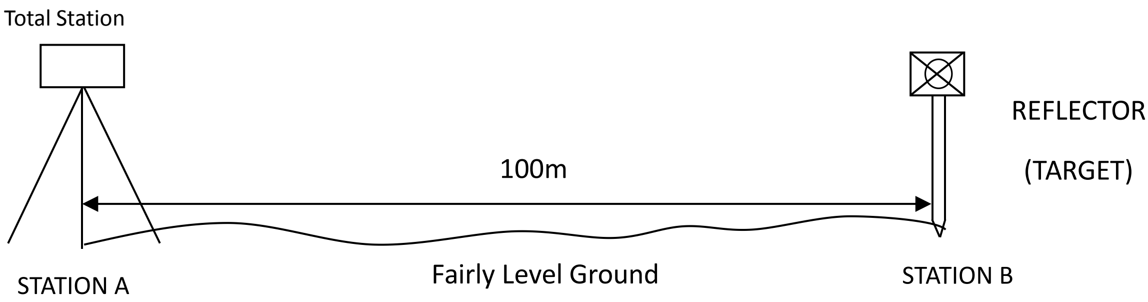


Fig 3.4.1.1: Horizontal Collimation and Vertical Index error test.

Table 3.4.1.1: *Horizontal Collimation Data*

Station	Target	Face	Hz Reading	Difference	Error
A	B	L	38˚42'32"		
		R	218˚42'35"	180˚00'03"	03"

3.4.1.2 Vertical Index Error Test

This test was performed to ensure that the vertical reading is exactly ninety degrees (90˚) when the line of sight is horizontal. Any deviation from this figure is known as vertical index error.

The Total Station was set over a point and necessary temporary adjustments were performed. A target set about 100m away from the Total station was sighted and bisected with the instrument on the face left and the reading was recorded. The target was also sighted and bisected on face right and the reading was also recorded. These readings are shown below

Table 3.4.1.2: *Vertical Index Data*

Instrument Station	Target Station	Face	Vertical	Sum	Error
A	B	L	90˚00’00”		
		R	270˚00’02”	360˚00’02”	02”

3.4.1.3 Analysis of Collimation and Vertical Index Data

The reading obtain during calibration were reduced to obtain new collimation and vertical errors.

Horizontal collimation = {(FR – FL) – 180}/2 = {(00˚00’03”}/2 = 1.5”

Vertical collimation = {(FL + FR) – 360} = (90˚00’00” + 270˚00’02”) - 360} = 02”

The result shows that the instrument is still in good working condition.

3.4.2 Digital Level Instrument

The level instrument employed for the research was Leica Digital level. Two pegs test was carried out on the digital level to check the collimation error of the instrument. The level instrument was set on a specific point A, with initial adjustments made for proper alignment, levelling, and focusing to eliminate parallax, it was now backsight on peg 1 and foresight on peg 2, the instrument was then now moved to another point B, and all the necessary adjustments were made, the peg 2 was bisected as backsight, and the peg 1 as foresight.

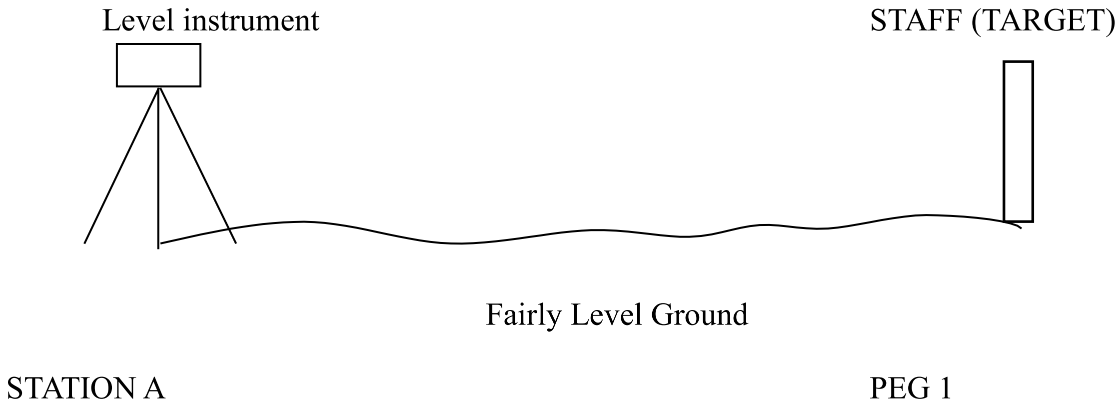


Fig3.4.1.1.: *Horizontal Collimation error test*

Table3.4.2.*Horizontal Collimation Data*

STATION	Remarks	BS	IS	FS	Diff.
A	Peg 1	1.734			
	Peg 2			2.042	
					0.308
B	Peg 2	1.578			
	Peg 1			1.262	
					0.316
	Collimation Error				**0.008**

The difference of the two-pegs test from 2 stations (0.008), shows the instrument is in good condition and can be used for the project.

3.5 Control Check

The control points were found along the road in Kwara State Polytechnic. In order to determine their correctness and their true position, one was used as station point KWPT 49 while the point KWPT 50 was used as the back sight. The coordinates obtained were compared with the received data from Department Field Data Records, the difference falls within the allowable accuracy of 3rd order survey job as can be seen in Table 3.3 below:

Table 3.3: *Analysis of control check*

PILLAR	**COORDINATE**	**EASTING(m)**	**NORTHING(m)**	**HEIGHT(m)**
KWPT 49	RECEIVED	674341.289	937679.115	353.682
	OBSERVED	674341.289	937679.115	353.682
	DIFFERENCE	0.000	0.000	0.000
PILLAR	COORDINATE	EASTING(m)	NORTHING(m)	HEIGHT(m)
KWPT 50	RECEIVED	674555.841	937679.115	353.682
	OBSERVED	674555.853	937679.097	353.691
	DIFFERENCE	0.012	0.018	0.009
Allowable accuracy		0.600	0.600	0.600

3.6 Data Acquisition

Data acquisition in land surveying refers to the process of collecting and recording data about the land, its features, and boundaries. This can include:

- Geometric data acquisition

- Attribute data acquisition

3.6.1 Geometric Data Acquisition

Geometric data acquisition involves collecting data that defines the spatial relationships and positions of features on the land. This can include:

1. Coordinates: Collecting X, Y, and Z coordinates of points on the land using instruments like total stations, GPS, and levels.
2. Distances and angles: Measuring distances and angles between points on the land using instruments like total stations and tape measures.
3. Elevations: Determining the height of points on the land above a reference datum using instruments like levels and GPS.

The geometric data of this project was obtained using the total station i.e. combination of electronic theodolite and the Electronic Distance Measurement (for X, Y, Z determination), and Level instrument (for height measurement) Geometric data are positional data, (i.e. they have the X, Y, Z) coordinates which make it easy to locate their actual position of features on the earth surface.

Here is a step-by-step procedure used for Total Station for geometric data acquisition:

Preparation

1. Setup: The Total Station was set over a known control point (KWPT 49).

2. Leveling: Level the instrument to ensure accurate measurements.

3. Orientation: It was done using two know control points KWPT 49(as occupy station) and KWPT 50(as backsight)

Data Collection

1. Target sighting: Sight the target (reflector) at the point to be measured.

2. Measurement: Determination of X, Y, Z of the target.

3. Recording: Record the measured data (coordinates).

4. Repeat: Repeat the process for each point to be measured.

Here's a step-by-step procedure used for Level instrument for data acquisition:

Preparation

1. Setup: The Level instrument was set on a stable surface, ensuring it's level and secure.

2. Leveling: Level the instrument using the built-in leveling mechanism.

3. Focus: The telescope was focused on the target (staff or rod).

Data Collection

1. Backsight: Took a backsight reading on a benchmark (KWPT 49).

2. Foresight: Take foresight readings on points to be measured, ensuring the staff is held plumb.

3. Reading: Record the readings, including the staff readings and points description.

4. Repeat: Repeat the process for each point to be measured.

3.6.2 Attributes Data Acquisition

Attribute data refers to information that describes the characteristics and properties of spatial features. It provides details such as names, classifications, and functions of geographic objects. In this study, the attribute data collected Include the names of buildings (e.g., lecture room of office), as well as information on roads. Handheld GPS was used to acquire attribute data for this project.

Handheld GPS units we used to gather attribute data by:

Collecting positional data: the GPS determines the location (LATITUTDE, Longtitude, and sometimes elevation) of the point where we standing.

Attaching attribute: you can then link attribute information to that location. This could be done by entering the information manually, (e.g. using the keypad on the GPS unit) or by uploading the data to a computer.

Saving the data: the GPS saves the location data along with the attributes, creating a dataset of points with associated information.

3.7 Perimeter, Detailing and Spot Heighting

Perimeter is the total distance covered along the boundary line and an area of land, the total distance covered is 1.214km. It is very important in order to get the exact location of a property. Traversing is a subordinate to perimeter and it may be defined as the process of connecting the series of lines with known bearing and distances (or XYZ).

The Total Station was carefully set up over control point KWPT49, with a back sight taken to point KWPT 50 after performing the necessary station adjustments, including cantering, levelling, and focusing, the KWPT50 (backsight) was measured and the observed coordinates was compared with given one, the difference is not significant and allowable. Then peg1 was established and measured in other to transfer the control to the site. The same procedure was repeated to determine the coordinates of the next point (peg2), and continued progressively until the site was reached. The radiation method was used for data acquisition, where two or more points were coordinated from a single instrument station.

The following steps outline the procedure:

I. After completing temporary adjustments, the instrument was powered on, and a new job titled *PRJT1* was created in the internal memory under the job menu.

II. In the coordinate menu, orientation was established by inputting the coordinates of the instrument station and back sight.

III. The height of the instrument and the reflector height were measured and entered into the instrument.

IV. The reflector at the back sight was accurately bisected before confirming the orientation.

V. Once oriented, the reflector was aimed at the next target (nail), and the "OBS" (observe) function was selected. The three-dimensional coordinates (Easting, Northing, and Height) were displayed and saved by pressing "REC" (record). For subsequent observations, the "ALL" option was used to streamline the process.

VI. It was ensured that the centre of the prism on the reflector was properly aligned and securely mounted on the tripod to minimize height determination errors.

VII. Once all visible details, including boundary points, spot heights and building, had been observed from the current station, the instrument was relocated to the next control nail, and the temporary adjustments were repeated.

This process was systematically carried out until all boundary points and elevation data were captured. In this project, spot heights were not recorded at regular grid intervals but were instead collected randomly after it has been pegged. For each building, three corner points were surveyed. Upon completing the data acquisition phase, all relevant features were accurately recorded and positioned accordingly on the final site plan.

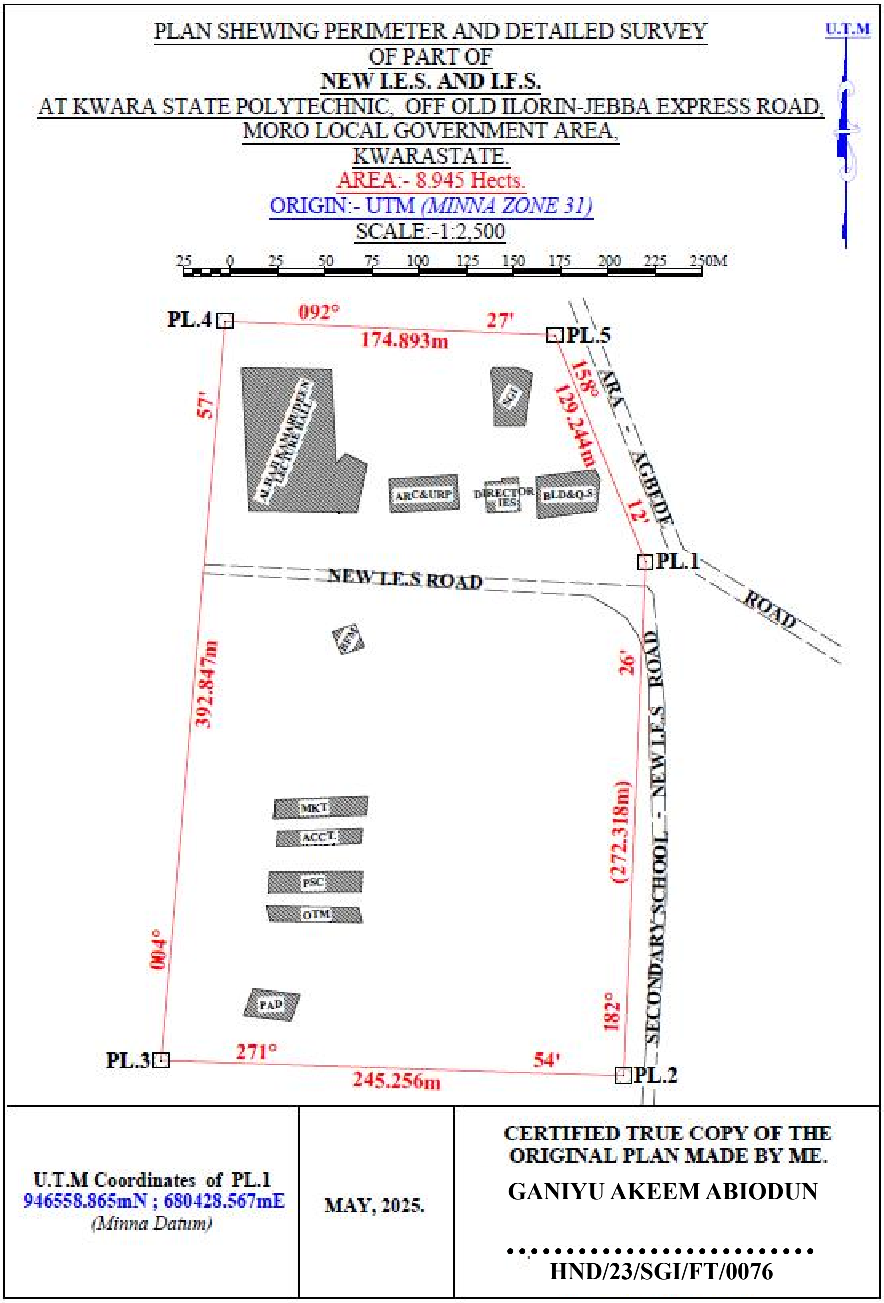
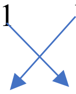
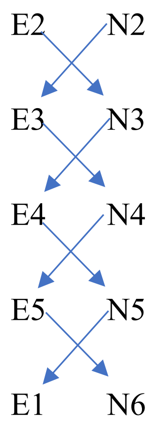


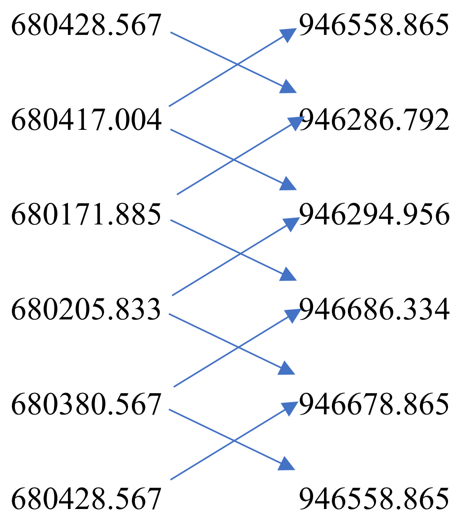
Figure 3.7: *Plan showing Perimeter and Detailed Survey.*

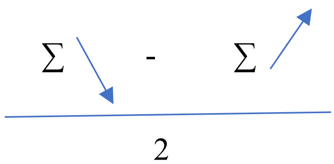
Area Computation using Cross Multiply Coordinates

E1 N1









$$\frac{460,787,138,011.03 - 460,786,959,116.36}{2}$$

$$\frac{178,894.67}{2}$$

Area = 89,447.335 sqft

Area = 8.945 hect.

CHAPTER FOUR

4.0 DATA DOWNLOADING, PROCESSING, ANALYSIS AND DISCUSSION

This chapter provides a detailed overview of the procedures involved in data download, data processing, correction, and data analysis conducted on the acquired data from the site and data presentation.

4.1 Data Download

All the recorded data was stored in the memory of the total station. To download the data, the total station was connected to a computer using a wired cable and downloading software. The software parameters were configured to match those of the instrument. The instrument's menu was accessed, and the memory manager was selected. From there, the "send data" option was chosen, and the file named "PRJT1" was located and downloaded to the computer through the software. The data was saved with a ".txt" file extension on the desktop of the laptop for further processing.

4.2 Data Editing

The downloaded geometric data were further processed to convert them into usable formats and improve their accuracy. The resulting coordinate data were edited using Notepad and Excel software. This file was then imported into AutoCAD2007 for additional processing.

4.3 Data Processing using Autocad 2007

Before using AutoCAD, we processed the coordinate data observed in the field by first transferring it into Notepad, then copying it into AutoCAD. The following steps outline the process for handling the data in AutoCAD:

1. Launch AutoCAD on the computer.
2. Click "New" from the application menu to start a new drawing.
3. Type UNITS in the command line and press Enter.
4. Select the desired unit type (e.g., decimal, architectural, engineering).
5. In the menu bar, select the "Polyline" tool.
6. Copy the data from Notepad and paste it into AutoCAD.
7. Type Z (for zoom) and press Enter, then type E (for extents) and press Enter to adjust the view.

4.4 Results and Discussion

Table 4.4: *Total station and Digital level Spot height Readings and their differences*

REMARKS	**EASTING**	**NORTHING**	**HEIGHT**		**DIFF.**
			T.S	**LEVEL**	
SH1	680272.275	946497.781	355.749	355.715	0.034
SH2	680267.717	946479.907	356.403	356.362	0.041

SH3	680273.327	946450.469	354.811	354.772	0.039
SH4	680287.358	946434.349	354.268	354.208	0.060
HSH5	680317.873	946433.648	355.036	354.984	0.052
SH6	680304.544	946455.727	355.710	355.668	0.042
SH7	680337.867	946463.436	355.448	355.386	0.062
SH8	680342.774	946441.708	356.295	356.240	0.055
SH9	680342.774	946441.708	356.736	356.680	0.056
SH10	680348.740	946443.460	355.971	355.931	0.040
SH11	680377.262	946451.836	355.725	355.673	0.052
SH12	680382.060	946482.711	355.318	355.277	0.041
SH13	680381.009	946518.108	354.819	354.766	0.053
SH14	680350.494	946509.345	355.174	355.128	0.046
SH15	680356.104	946484.813	355.033	355.005	0.028
SH16	680332.603	946480.960	355.228	355.188	0.040
SH17	680308.051	946470.796	355.517	355.464	0.053
SH18	680298.581	946490.422	355.834	355.802	0.032
SH19	680318.222	946506.191	355.726	355.678	0.048
SH20	680308.753	946526.168	356.148	356.096	0.052
Mean			**355.8163**	**355.7726**	**0.0437**
Variance			**2.5758**	**2.5881**	**0.0123**
Standard Deviation			**1.6049**	**1.6088**	**0.0039**

Working Formulas for Mean, Variance and Standard Deviation Calculation

The mean is calculated as:

$$\mu = \frac{\sum x_i}{n}$$

$\mu =$ mean

$x_i =$ each point height

$n =$ number of points

The variance is calculated as:

$$^{2} = \frac{\sum (x_i - \mu)^2}{n}$$

$^{2} =$ variance

$x_i =$ each point height

$\mu =$ mean

$n =$ number of points

The Standard Deviation is calculated as:

$$= \sqrt{\quad ^{2}}$$

$=$ standard deviation

$^{2} =$ variance

Mean calculation for Total Station Height readings

$$\mu = \frac{\sum x_i}{n}$$

$$\mu = \frac{355.749+356.403+354.811+354.268+355.036+355.710+355.448+356.295+356.736+355.971+355.725+355.318+354.819+355.174+355.033+355.228+355.517+355.834+355.726+356.148}{20}$$

$$\mu = \frac{7116.326}{20}$$

$$\mathbf{\mu = 355.8163}$$

Mean calculation for Reduced Level Height readings

$$\mu = \frac{355.715+356.362+354.772+354.208+354.984+355.668+355.386+356.240+356.680+355.931+355.673+355.277+354.766+355.128+355.005+355.188+355.464+355.802+355.678+356.096}{20}$$

$$\mu = \frac{7115.452}{20}$$

$$\mathbf{\mu = 355.7726}$$

Mean calculation for Total Station Height readings - Mean calculation for level height readings 355.8163 – 355.7726 = 0.0437

$$^2 = \frac{\sum (xi - \mu)^2}{n}$$

$$^2 = \sum (xi - \mu)^2$$

$$\overline{\quad n \quad}$$

$$\frac{0.0673^2+0.5867^2+1.0053^2+1.5483^2+0.5327^2+0.2521^2+0.1582^2+0.4126^2+0.9284^2+0.0992^2+0.1104^2+0.1327^2+1.0217^2+0.6184^2+0.7834^2+0.4926^2+0.2581^2+0.0164^2+0.0428^2+0.3317}{20}$$

$$^2=\frac{51.516}{20}$$

$$^2=\mathbf{2.5758}$$

Variance calculation for Reduced Level Height readings

$$\frac{0.576^2+0.5894^2+1.006^2+1.5686^2+0.5285^2+0.2375^2+0.1382^2+0.4103^2+0.9126^2+0.0821^2+0.1013+0.1104^2+1.0102^2+0.6014^2+0.7695^2+0.4818^2+0.2443^2+0.0071^2+0.0289^2+0.32047}{20}$$

$$^2=\frac{51.762}{20}$$

$$^2=\mathbf{2.5881}$$

Variance calculation for total station – variance calculation for level height readings 2.5758 – 2.5881 = 0.0123

The Standard Deviation for Total Station Height readings:

$$=\sqrt{\quad}\ ^2$$

$$=\sqrt{2.5758}$$

$$=\mathbf{1.6049}$$

The Standard Deviation for Reduced Level Height readings:

$$= \sqrt{2.5881}$$

$$= \mathbf{1.6088}$$

The standard deviation for total station – standard deviation for level height reading 1.6049 – 1.6088 = 0.0039

The table above shows the station Id, eastings, northings, total station height, digital level reduced level and the difference between the total station height and the digital level reduced level.

The comparison of the two pieces of equipment revealed variations within a specific range. The differences observed between the two pieces of equipment were found to be in the range of 0.028 to 0.062 meters. These differences indicate slight disparities in the measurements obtained from each instrument. Statistical analysis was performed to evaluate the mean, variance, and standard deviations of the observed differences. The mean difference was calculated to be 0.0437, indicating an average deviation between the measurements obtained by the two equipment. The variance, which quantifies the spread of the differences, was found to be 0.0123.

This value suggests that the variations in the measurements obtained by the two pieces of equipment were relatively consistent. The standard deviation, which provides a measure of the dispersion of the data, was determined to be 0.0039. This indicates that the differences between the measurements obtained from the two pieces of equipment had a moderate level of variability.

Overall, the results of the analysis demonstrate that there were slight variations between the measurements obtained from the two pieces of equipment. The mean, variance, and standard deviations provide insights into the magnitude and consistency of these differences, offering valuable information for assessing the accuracy and reliability of the equipment in question.

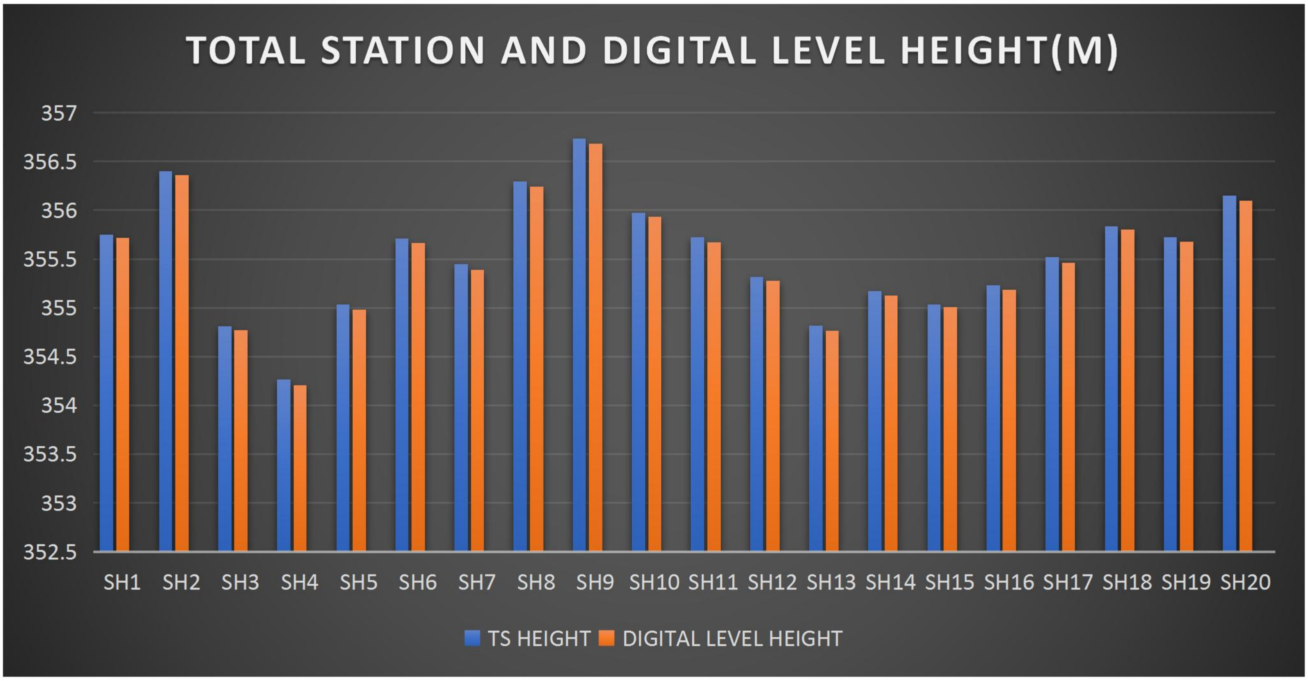


Figure 1:*Bar chart showing heights obtained from the total station and level instrument*

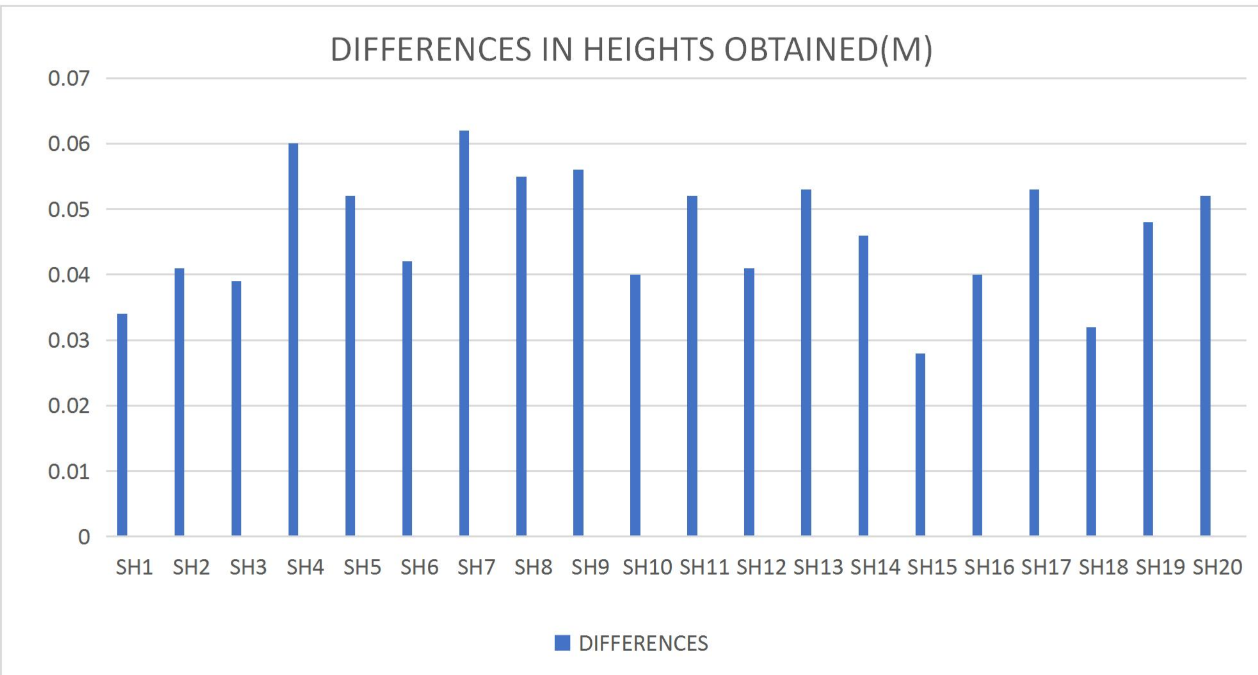
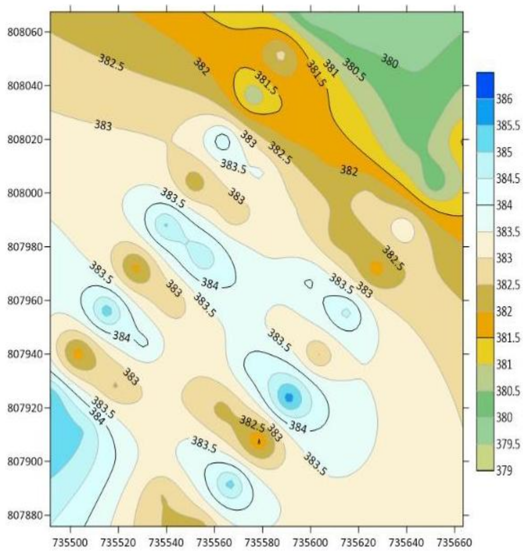


Figure 2:*Histogram showing the difference in the two instrument's result*

The histogram presented above illustrates the distribution of deviations between the two methods being compared. The deviations are depicted in centimeter, showcasing the level of accuracy achieved by both methods. The histogram highlights that the deviations are tightly clustered and exhibit a consistent pattern.

CONTOUR MAP USING AUTO LEVEL



CONTOUR MAP USING TOTAL STATION

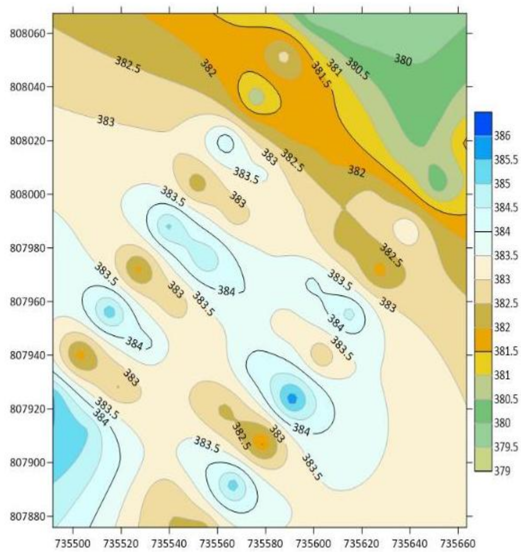


Figure 3. *Showing the contour map obtained from the two instruments.*

3-D SURFACE MODEL USING AUTO LEVEL

3-D SURFACE MODEL USING TOTAL STATION

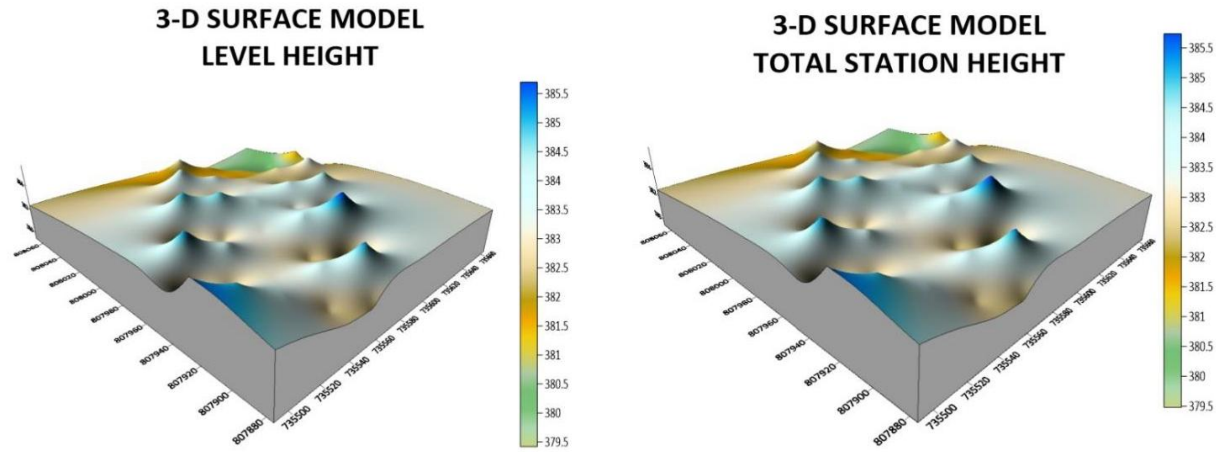


Figure 4:*Showing the 3D surface map obtained from the two instruments*

The mean of the deviations, calculated to be 0.0437m, provides an indication of the average difference between the measurements obtained from the two methods. This value signifies a small average deviation, suggesting that the two methods generally yield similar results with minimal variation.

The histogram provides a visual representation of the data, allowing for a comprehensive understanding of the distribution of deviations. By examining the histogram, one can observe the concentration of deviations around the mean value, indicating a central tendency in the measurements obtained by the two methods.

The centimeter-level accuracy exhibited by the deviations underscores the precision of the measurement techniques employed. This level of accuracy is crucial, particularly in applications that require high precision, such as engineering, construction, or geospatial analysis. The contour maps presented above exhibit strikingly similar patterns, which serve as a testament to the high degree of precision achieved by the instruments used. The consistent and replicated patterns observed on the maps reinforce the reliability and accuracy of the measurements obtained.

The similarity in the contour patterns indicates that the instruments employed in the surveying process were able to capture the subtle variations in elevation with great precision.

This level of accuracy is crucial in applications such as topographic mapping, land surveying, and engineering, where even minor deviations can have significant implications. By displaying the contours of the surveyed area, the maps provide a visual representation of the landscape's topography and elevation changes.

The congruity in the contour lines across the maps signifies that the instruments effectively captured and recorded the elevation data, resulting in a reliable representation of the terrain

4.5 Statistical Analysis

A statistical investigation was carried out using Paired Two Samples as Means to test whether there is any significant difference in the performance of the two instruments for terrain height determination. The independent sample t-test is a member of the t-test family, which consists of tests that compare mean value(s) of continuous-level (interval or ratio data), normally distributed data (Hinton, 2004). The independent-sample t-test evaluates the difference between the means of two independent or unrelated groups. That is, we evaluate whether the means for the two independent groups are significantly different from each other.

Hypothesis

A hypothesis was set up and tested using an Independent – sample T-Test:

1. Null Hypothesis: H0: There is no difference between the terrain height obtained from the total station and digital level instrument.

2. Alternative Hypothesis: H1: There is a difference between terrain height obtained from total station and digital levelling instrument.

The null hypothesis is rejected if the calculated t value has a probability sig. (p) greater than the chosen significance level. An Independent sample T-Test was used in testing the hypothesis at a significance level of 0.05. Data analysis Package extension in Excel was activated and used in running the T-Test.

Table 4.5: *T-Test: Two-Sample Assuming Unequal Variances*

	Digital Level	**Total Station**
Mean	355.77262	355.81628
Variance	2.588092118	2.575687471
Observations	20	20
Pearson Correlation	0.032104369	0.031950494
Hypothesized Mean Difference	0.001605218	0.001597525
t Stat	0.056215684	0.056208782
P(T<=t) one-tail	0.145413689	0.144776257
P(T<=t) two-tail	0.290982737	0.289552551
Sum	7096.631	7095.814
Kurtosis	2.049052417	2.0403051292

Skewness	0.612867732	0.5907755549
Median	354.772	354.811
Maximum	356.680	356.736
Minimum	354.208	354.268
Range	2. 472	2.468

The statistical data provided supports our discussion by indicating a high degree of agreement and consistency between the digital level and total station measurements. The mean values are very close, the variances are similar, and the Pearson correlation coefficient indicates a strong linear relationship. The t-test results suggest that any observed difference between the two instruments' means is likely due to random variation rather than a significant discrepancy. After carrying out the project, we observe that digital level is more accurate than total station, although the different can be quite small.

CHAPTER FIVE

5.0 COSTING, SUMMARY, RECOMMENDATION AND CONCLUSION.

5.1 Cost Estimation of the Project

The project costing was based on number of variables which includes area to be covered, instruments, personnel, transportation and so on. However, another critical factor to be considered is the time duration in which the project was executed. The table below shows the duration the project was accomplished.

Table 5.1: Scheduled and Duration of the Project Execution

Description	Duration (Days)
Reconnaissance	1

Beaconing / Monumentation	1
Spot height points establishment	1
XYZ acquisition of the spot height points (using TS)	1
Height observation of the spot height points (using level instrument)	1
Detailing (using handheld GPS)	1
Data Downloading / Processing	3
Plotting and Report Writing	7
Submission of Report and Plan	5
Total No. of Days Spent for the Project	**21**

5.1.1 Project Costing Breakdown

Costing of this project was based on Professional Scale of Fees as approved by Nigerian Institution of Surveyor (NIS) in 2017 using 1996 Federal Government Approved Scale of Fees for Consultants in the Construction Industry. The prevailing inflation rate as at February 2023 was 21.91 % and this was applied to the cost estimate.

Table 5.2: Worked out Calculation for the grand Total Cost

S/N	OPERATION	RATE/DAY	NO OF DAYS	UNIT COST (#)	AMOUNT (#)
1	**RECONNISSANCE(1 DAY)**				
	4 Technician	15,189.11	1	15,189.11 x 4	60,756.40
	1 Skilled Labour	9,468.61	1	9,468.61x 1	9,468.61
	Transportation (Field vehicle + Driver / Mechanic + fuel	46,027.61	1	46,027.61 x 1	46,027.61
	Basic equipment (Hand held GPS etc.)	46,027.61	1	46,027.61 x 1	46,027.61
	SUB TOTAL				**157,546.00**
2	**(A) BEACONS** (5) (standard Cadastral Beacon)	5,000 per Beacon		5,000 x 5	25,000.00
	(B) BEACONING/ MONUMENTATION (1 day)				

	6 Surveyors	15,189.11	1	6x 15,189.11x 1	91,134.11
	3 Skilled Labour	9,468.61	1	3x 9,468.61x 1	28,405.83
	Transportation (Field vehicle + Driver / Mechanic + fuel)	46,027.61	1	46,027.61 x 1	46,027.61
	Basic tools (Crow bar, Trowel, Shovel etc)	13,929.00	1	13,929.00x 1	13,929.00
	SUBTOTAL				**179,496.55**
3	**Spot Height Establishment (1 DAY)**				
	2 surveyors	15,189.11	1	2x15,189.11 x 1	30,378.22
	3 Unskilled Labour	9,468.61	1	3 x9,468.61x 1	56,811.66
	Basic Equipment	46,027.61	1	46,027.61x1	92,055.22
	Transportation (Field vehicle +	46,027.61	1	46,027.61 x 1	92,055.22

	Driver / Maintenance + Fuel)				
	SUBTOTAL				**271,300.32**
4	**XYZ ACQUISITION USING (TS) (1 DAY)**				
	1 Senior Surveyor	22,783.67	1	1x 22,783.67 x 2	45,567.34
	2 Surveyors	15,189.11	1	2 x15,189.11 x 2	60,756.44
	2skilled Labour	9,468.61	1	2 x9,468.61x 2	37,874.44
	Basic Equipment	46,027.61	1	46,027.61x 2	92,055.22
	Transportation (Field vehicle + Driver / Maintenance + Fuel)	46,027.61		46,027.61 x 2	92,055.22
	SUBTOTAL				**328,308.66**
5	**HEIGHT OBSERVATIION**				

	(LEVEL INSTRUMENT) **(1DAY)**				
	1 Senior Surveyor	22,783.67	1	1x 22,783.67 x 2	45,567.34
	2 surveyors	15,189.11	1	2 x15,189.11 x 2	60,756.44
	2skilled Labour	9,468.61	1	2 x9,468.61x 2	37,874.44
	Basic Equipment	46,027.61	1	46,027.61x 2	92,055.22
	Transportation (Field vehicle + Driver / Maintenance + Fuel)	46,027.61	1	46,027.61 x 2	92,055.22
	SUBTOTAL				**328,308.32**
6	**DETAILING** **(1 DAY)**				
	2 Surveyors	15,189.11	1	2x 15,189.11x 1	30,378.22
	3 Skilled Labour	9,468.61	1	3x 9,468.61x	28,405.83

				1	
	Transportation (Field vehicle + Driver / Mechanic + fuel)	46,027.61	1	46,027.61 x 1	46,027.61
	Basic Equipment	46,027.61	1	46,027.61x 1	46,027.61
	SUBTOTAL				**150,839.27**
7	**DATA DOWNLOADING / PROCESSING (3 DAYS)**				
	1 Senior Surveyor	22,783.67	3	22,783.67 x 3	68,351.01
	2 surveyors	15,189.11	3	2x15,189.11 x 3	91,134.66
	Computer Accessories	49,315.28	3	49,315.28 x 3	147,945.84
	SUBTOTAL				**307,431.51**
8	**PLOTTING AND REPORT WRITTING**				

	(7 DAYS)				
	1 Senior Surveyor	22,783.67	7	1x22783.67 x 7	159,485.69
	2 surveyors	15,189.11	7	2x15,189.11 x 7	212,647.54
	Standard set (computer, plotter etc)	65,753.70	7	1x65,753.70 x 7	460,275.90
	SUBTOTAL				**832,409.13**
9	**SUBMISSION OF REPORT AND PLAN (1 DAY)**				
	1 Chief Surveyor	30,800.00	1	30,800.00x 1	30,800.00
	2 surveyors	15,189.11	1	2x 15,189.11x 1	30,378.22
	1 Computer	46,027.61	1	46,027.61 x 1	46,027.61
	Consumables	13,929.00	1	13,929.00 x 1	13,929.00
	SUBTOTAL				**121,135.41**

COST OF TH]E PROJECT =					**2,676,775.17**
ACCOMODATION(15% of the cost of the project)					595,177.22
MOBILIZATION/DEMOBILIZATION (10% of cost of the project) =					396,784.81
CONTINGENCIES (5% of cost of the project) =					198,392.41
VAT (7.5% of the Total cost of the project)=					297,588.61
ACTUAL BILL/ GRAND TOTAL =					**4,164,718.22**

Hence, the total cost of expenditure used for comparative evaluation of digital levelling and total station equipment for height measurement project was estimated to be Four Million, One Hundred and Sixty Four Thousand, Seven Hundred Eighteen Naira, Twenty Two Kobo only.

5.2 Summary

The comparative evaluation of digital levelling and total station equipment for height measurement reveals that both tools have their advantages and disadvantages. Digital levelling offers high precision and accuracy, particularly in precise levelling tasks, whereas total station equipment provides flexibility and versatility in various surveying applications. The project demonstrates that the choice between these two instruments depends on the specific requirements of the project, including the range, precision, and type of measurement.

The results of this research contribute to a deeper understanding of the capabilities and limitations of digital levelling and total station equipment, ultimately enhancing the accuracy and reliability of height measurements in various fields.

5.3 Recommendation

This project recommends that surveying professionals and organizations invest in both digital levelling and total station equipment, as both tools have distinct strengths and limitations. By having access to both tools, professionals can select the most suitable equipment for specific projects, ensuring the accuracy and reliability of height measurements. Furthermore, it is recommended that professionals stay up-to-date with the latest technological advancements and best practices in surveying, to ensure that they are using the most effective and efficient methods for height measurement.

5.4 Conclusion

This comparative evaluation has provided valuable insights into the accuracy and reliability of digital levelling and total station equipment for height measurement. The project's findings demonstrate that digital leveling excels in precise leveling tasks, while total station equipment offers versatility and flexibility in various surveying applications. In conclusion, the choice between these two tools depends on the specific requirements of the project, including the range, precision, and type of measurement. By selecting the most suitable equipment, surveying professionals can ensure the accuracy and reliability of height measurements, ultimately contributing to the success of their projects. This project's results have significant implications for the development of more effective surveying methodologies and the advancement of surveying practices.

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APPENDIX

ID	EASTING	NORTHING	TS HEIGHT	LEVEL HEIGHT
PL.1	680428.567	946558.865	356.128	
PL.2	680417.004	946286.792	354.746	
PL.3	680171.885	946294.956	353.013	
PL.4	680205.833	946686.334	357.652	
PL.5	680380.567	946678.865	356.849	
SH1	680272.275	946497.781	355.749	355.715
SH2	680267.717	946479.907	356.403	356.362
SH3	680273.327	946450.469	354.811	354.772
SH4	680287.358	946434.349	354.268	354.208

SH5	680317.873	946433.648	355.036	354.984
SH6	680304.544	946455.727	355.710	355.668
SH7	680337.867	946463.436	355.448	355.386
SH8	680342.774	946441.708	356.295	356.240
SH9	680342.774	946441.708	356.736	356.680
SH10	680348.740	946443.460	355.971	355.931
SH11	680377.262	946451.836	355.725	355.673
SH12	680382.060	946482.711	355.318	355.277
SH13	680381.009	946518.108	354.819	354.766
SH14	680350.494	946509.345	355.174	355.128
SH15	680356.104	946484.813	355.033	355.005
SH16	680332.603	946480.960	355.228	355.188
SH17	680298.581	946490.422	355.834	355.802
SH18	680318.222	946506.191	355.726	355.678
SH19	680308.753	946526.168	356.148	356.096
SH20	680342.774	946441.708	356.736	356.680

SHOPRITE 680275.567 946584.865 , S.G.I 680364.567 946630.865

SHOPRITE	680229.567	946585.865	,	S.G.I	680368.567	946658.865
SHOPRITE	680218.567	946585.865	,	S.G.I	680360.567	946661.865
SHOPRITE	680214.567	946661.865	,	S.G.I	680347.567	946661.865
SHOPRITE	680262.006	946660.833	,	S.G.I	680346.567	946659.865
SHOPRITE	680264.633	946610.907	,	S.G.I	680348.567	946639.865
SHOPRITE	680269.493	946616.306	,	S.G.I	680348.567	946630.865
SHOPRITE	680281.021	946610.551	,	S.G.I	680364.567	946630.865
SHOPRITE	680281.021	946610.551				
DRCT. IES	680344.567	946584.865	,	BLD&QS	680371.567	946581.865
DRCT. IES	680343.551	946601.098	,	BLD&QS	680370.514	946603.802
DRCT. IES	680352.430	946601.591	,	BLD&QS	680401.497	946607.815
DRCT. IES	680352.329	946603.210	,	BLD&QS	680404.537	946602.905
DRCT. IES	680361.208	946603.703	,	BLD&QS	680402.499	946585.830
ARC&URP	680328.567	946604.865	,	BFM	680262.567	946521.871
ARC&URP	680292.567	946602.865	,	BFM	680267.567	946509.867
ARC&URP	680293.684	946585.013	,	BFM	680279.567	946513.862
ARC&URP	680329.684	946587.013	,	BFM	680274.567	946525.865

MKT.	680215.442	946426.097	,	ACCT.	680262.660	946428.209
MKT.	680214.930	946436.134	,	ACCT.	680218.483	946419.645
MKT.	680263.075	946445.466	,	ACCT.	680218.891	946411.655
MKT.	680263.587	946435.430	,	ACCT.	680263.068	946420.219
PHYS.	680266.105	946405.563	,	OTM.	680266.988	946386.384
PHYS.	680267.046	946394.755	,	OTM.	680218.393	946380.018
PHYS.	680218.331	946387.08	,	OTM.	680221.571	946372.409
PHYS.	680217.389	946397.897	,	OTM.	680270.166	946378.775
PAD.	680240.402	946321.660				
PAD.	680215.235	946320.874				
PAD.	680218.077	946335.465				
PAD.	680243.244	946336.252				