CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

In scientific studies and engineering works, it is required to determine height differences between points or the height of points itself in those applications such as measurements of national or local networks, vertical applications of the bridge, dam and infrastructures, maintenance and control measurements, determination of vertical crustal movements, motorway, railway, sewerage, and pipeline measurements. Precise height determination is also required for photogrammetric and remote sensing purposes (Ayhan et al, 2005).

Height measurement is a critical aspect of surveying and mapping applications, providing essential information for various engineering, construction, and geospatial projects. Accurate height data is necessary for determining elevations, creating topographic maps, monitoring terrain changes, and designing infrastructure.

Vertical surveying (levelling) is the process of determining elevations above a chosen datum, Mean Sea Level. In geodetic surveys, a geodetic position (y, x) refers to an ellipsoid, and the elevations of those positions referenced to the geoid. Precise geodetic levelling surveys will establish the basic network of vertical control points (Wang and Soler, 2015).

Traditionally, surveyors have used instruments like leveling equipment to measure heights with high precision and accuracy. With the advancement of technology the determination of the coordinates(XYZ) 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

Total station is an optical instrument commonly used in surveying. It is useful for measuring horizontal angles, vertical angles and distance; it does this by analyzing the slope between itself and a specific point.

The basic properties are unsurpassed range, speed and accuracy of measurements. Total stations are developed in view of the maximal convenience of work of the user.

However, despite the advancements in technology, there is still a need to comparatively evaluate the performance of digital leveling and total station equipment. The comparison of height measurements obtained using total station and leveling instrument is vital to understand the strengths and limitations of each method.

1.2 Statement of the problem

The accuracy and precision of height measurements are essential in many surveying and engineering projects. Total station and leveling instrument are commonly used technologies for measuring height above a reference point, but there is a lack of comprehensive research comparing the accuracy and efficiency of these two methods.

The main problem to be addressed in this project is to determine the difference in height measurements obtained using total station and leveling instrument, additionally, to assess the cost-effectiveness, reliability, and suitability of each method for different surveying applications.

By evaluating the strengths and limitations of total station and leveling instrument for height measurement, this project seeks to provide valuable insights for choosing the most appropriate technology based on project requirements and constraints.

1.3 Aim of the Project

The aim of this project is to compare the accuracy and precision of height measurements obtained using a total station and levelinginstrument.

1.4 Objectives of the Project

The following are the objectives of the project

1. To compare the accuracy and precision of height measurements obtained using a total station and leveling instrument.
2. To evaluate the strengths and limitations of total station and leveling instrument indetermining height.
3. To assess the reliability and potential sources of error in height measurements conducted using each instrument.
4. To provide recommendations for selecting the most appropriate height measurement method based on project requirements and constraints.

1.5 Scope of the Project

This project will focus on comparing height measurements using a total station and leveling instrument in a controlled test environment with known elevation control points. 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

At the end of the project, the research should be able to identify and ascertain the accuracy of both methods and able to determine which method provides the most cost-effective solution for height data collection.

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

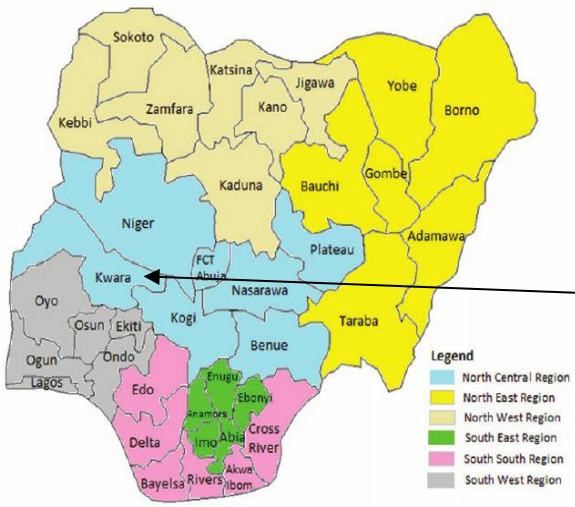
The projectwas successfully carried by the personnel listed below;

NAME	MATRIC. NO.	
Adeoti Qudus Adebayo	HND/23/SGI/FT/0080	Writer
Abdul Kareem Ramota Olawumi	HND/23/SGI/FT/0078	Member
Kazeem Kabirat Damilola	HND/23/SGI/FT/0079	Member
Ganiyu Akeem Abiodun	HND/23/SGI/FT/0076	Member
Adeleye Sheriffdeen Olawale	HND/23/SGI/FT/0081	Member

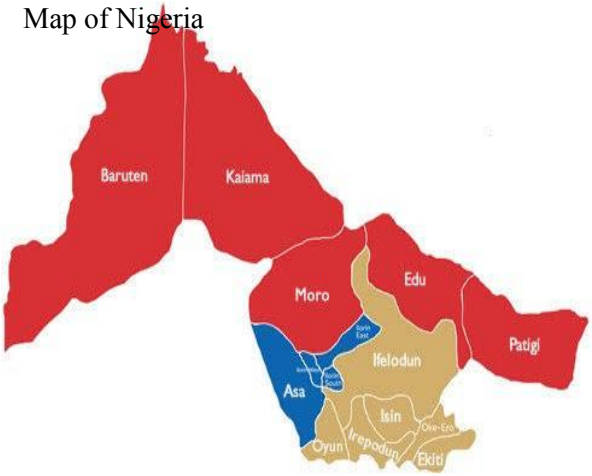
Abdul Qudus Shukurah Temitope	HND/23/SGI/FT/0083	Member
Ogunsuyi Babatunde Sunday	HND/23/SGI/FT/0118	Member
Jimoh Halimah Titilayo	HND/22/SGI/FT/082	Member

1.9 Project Location

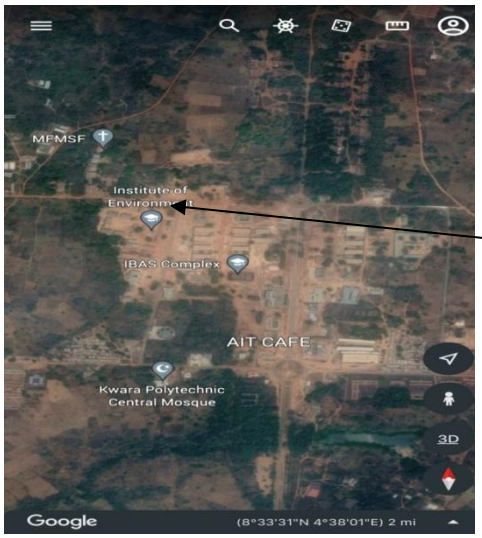
The project site is located inside Kwara state polytechnic Ilorin, Kwara state is a significant provider of technical and vocational education and is situated in Ilorin, Nigeria. Spread across a wide area, it is roughly located at latitude 8.4791^{0}N and longitude $4.5418\ ^{0}$E



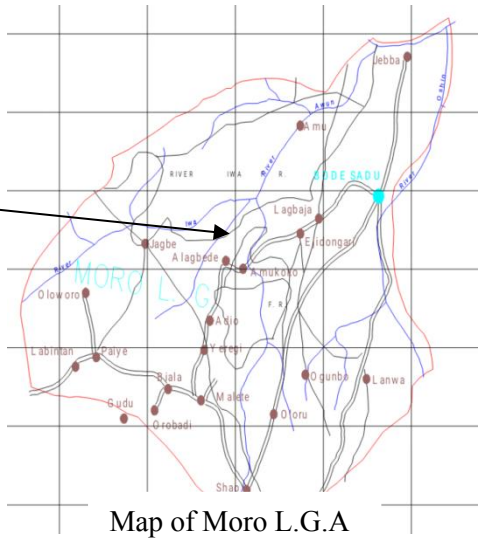
Map of Nigeria



Map of Kwara State



Google Imagery of the Study Area



Map of Moro L.G.A

***Figure 1.10**: Study Area Map*

CHAPTER TWO

2.0 LITRATURE REVIEW

2.1 Introduction

Height measurement is a fundamental aspect of surveying and geodesy, and its accuracy plays a crucial role in various applications such as construction, engineering, and mapping. With the advancement of technology, various instruments have been developed to measure heights with high accuracy and precision. Two popular instruments used for height measurement are Digital Leveling instruments and Total Stations.

The accuracy and reliability of height measurements directly impact the quality and safety of projects (Kavanagh & Bird, 2017). In recent years, advances in technology have led to the development of digital leveling and total station equipment, which have improved the efficiency and accuracy of height measurements (Schwarz & El-Sheimy, 2011).

2.2 Total Station

2.2.1 Overview

A Total Station (TS) is a modern surveying instrument that integrates an electronic theodolite with an Electronic Distance Meter (EDM). Total stations use electronic transit theodolites in conjunction with a distance meter to read any slope distance fromthe instrument to any particular spot. They are hence two essential surveying instruments in one and when used with other technology such as mapping software are able to deliver the ‘total’ surveying package, from measuring to mapping. The development of total stations has markedly increased productivity in the surveying profession in many ways. Improved accuracy is one of the major advantages of total station. Now GPS technology can be used by a total station to

include unseen points in the survey. Other increases in productivity are due to efficiency and functionality. Total Stations also include up-to-date image capture

technology, which can record any image or screen-view from the surveying site, eliminating the need for costly revisits, and

producing high-resolution images of site conditions. A total station has electronic documentation and sketching functions, which reduces the need for paper field notes.

2.2.2 Accuracy of Total Station

Total Stations are known for their high precision and accuracy in measuring angles and distances:

- Angular Accuracy:- Typically ranges from 0.5 to 5 arc-seconds (Schofield & Breach, 2007).
- Distance Accuracy:- Usually within 1 to 2 millimeters plus 2 parts per million (ppm) of the distance measured (Wolf & Ghilani, 2012).

2.2.3 Factors Affecting Accuracy of Total Station

- Instrument Calibration:- Regular calibration ensures high accuracy.
- Line of Sight:- Requires a clear line of sight between the instrument and the target.
- Environmental Conditions:- Weather conditions like heat waves and wind can affect measurements.
- Operator Skill:- Proficiency of the operator in setting up and using the instrument.
- Target Quality:- Reflective prisms and targets must be properly maintained.

2.2.4 Applications of Total Station in Height Measurement

Total Station is a versatile instrument used in surveying and geodesy for various applications, including height measurement. Here are some of the applications of Total Station in height measurement:

1. Topographic Surveying: Total Station is used to measure the height of points on the Earth's surface for topographic surveying (Schwarz, 2002). This is essential for creating detailed topographic maps and models.

2. Engineering Surveying: Total Station is used to measure the height of points for engineering surveying, such as for the construction of buildings, roads, and bridges (Kavanagh, 2003).

3. Geodetic Surveying: Total Station is used to measure the height of points for geodetic surveying, such as for determining the shape of the Earth and the precise location of points on its surface (Vaníček, 2005).

4. Monitoring of Structures: Total Station is used to monitor the height of structures, such as buildings and bridges, to detect any changes or movements (Schwarz, 2002).

5. Deformation Monitoring: Total Station is used to monitor the deformation of structures, such as tunnels and dams, by measuring the changes in height and position of points on the structure (Kavanagh, 2003).

2.2.5 Advantages of Total Station in Height Measurement

Total Station is a versatile instrument used in surveying and geodesy for measuring heights, distances, and angles. Here are some of the advantages of using Total Station in height measurement:

1. High Accuracy: Total Station provides high accuracy measurements, typically within ± 2-5 mm over short distances (Schwarz, 2002).

2. Long-Range Capability: Total Station can measure heights over long distances, typically up to 5 km (Kavanagh, 2003).

3. Fast Measurement: Total Station allows for fast measurement, typically within seconds (Vaníček, 2005).

4. Versatility: Total Station can be used for various applications, including topographic surveying, engineering surveying, geodetic surveying, and monitoring of structures.

5. Automatic Data Recording: Total Station can automatically record data, reducing errors and increasing efficiency (Kavanagh, 2003).

2.2.6 Limitations of Total Station in Height Measurement

1. Atmospheric Conditions: Weather conditions such as fog, rain, and extreme temperatures can affect the accuracy of Total Station measurements (Schwarz, 2002).

2. Multipath Errors: Signals can bounce off nearby surfaces, causing multipath errors that can affect the accuracy of measurements (Vaníuser, 2005).

3. Instrument Calibration: Total Station requires regular calibration to ensure accurate measurements, which can be time-consuming and costly (Kavanagh, 2003).

4. Operator Error: Human error can occur during measurement, such as incorrect instrument setup or data entry (Schwarz, 2002).

2.3 Leveling Instrument

2.3.1 Overview

Levelling is the operation required in the determination, or more strictly, the comparison of heights of points on the surface of the earth (Bannister et al., 1992). Levelling is useful in designing highways, railways and canals, setting out projects according to planned elevations, calculating volumes of stacks, earthworks and embankments, investigating and laying out of drainage systems among other uses. There are various methods of determining difference in elevation of points. They include; taping methods, differential levelling, barometric levelling, trigonometric leveling and the modern methods such as GPS levelling. Spirit levelling isa surveying technique that employs spirit levels to orient the line of sight to coincide with the horizontal line in order to determine change in elevations between two points. Spirit levelling observations were carried out with automatic levelling instrument and alevelling staff. The levelling procedure is performed by taking a back sight reading to a levelling staff placed vertically at a benchmark, then reading a foresight on a staff placed on a point whose height is to be determined.

2.3.2 Accuracy of Digital Leveling Instruments

Digital leveling instruments are electronic instruments that use sensors to measure the difference in height between two points. The accuracy of digital leveling instruments depends on various factors, including the type of instrument, the quality of the instrument, and the environmental conditions.

Types of Digital Leveling Instruments and Their Accuracy

- Basic Digital Level: ± 1-2 mm/km (Kavanagh, 2003)
- Advanced Digital Level: ± 0.5-1 mm/km (Schwarz, 2002)
- High-Precision Digital Level: ± 0.1-0.5 mm/km (Vaníček, 2005)

2.3.3 Factors Affecting the Accuracy of Digital Leveling Instruments

- Instrument calibration: Instrument calibration is crucial to ensure accurate measurements (Kavanagh, 2003).
- Atmospheric conditions: Atmospheric conditions such as temperature, humidity, and air pressure can affect the accuracy of measurements (Schwarz, 2002).
- Measurement technique: The measurement technique used can also affect the accuracy of measurements (Vaníček, 2005).
- Operator error: Operator error can also affect the accuracy of measurements (Kavanagh, 2003).

2.3.4 Applications of Digital Leveling Instruments

Digital Leveling Instruments are versatile tools used in various fields to measure the difference in height between two points. Here are some of the applications of Digital Leveling Instruments:

1. Surveying and Mapping**:** Digital Leveling Instruments are used in surveying and mapping to measure the height of points on the Earth's surface (Kavanagh, 2003).

2. Construction and Building: Digital Leveling Instruments are used in construction and building to measure the height of buildings, bridges, and other structures (Schwarz, 2002).

3. Monitoring of Structures: Digital Leveling Instruments are used to monitor the height and settlement of structures, such as buildings, bridges, and towers (Kavanagh, 2003).

4. Geodetic Surveying: Digital Leveling Instruments are used in geodetic surveying to measure the height of points on the Earth's surface with high accuracy (Schwarz, 2002).

5. Land Surveying: Digital Leveling Instruments are used in land surveying to measure the height of points on the Earth's surface for property boundary determination (Vaníček, 2005).

6. Mining and Quarrying: Digital Leveling Instruments are used in mining and quarrying to measure the height of excavations and monitor the movement of rock and soil (Kavanagh, 2003).

7. Archaeological Surveying: Digital Leveling Instruments are used in archaeological surveying to measure the height of ancient structures and monuments (Schwarz, 2002).

2.3.5 Advantages of Digital Leveling Instruments

1. High accuracy: Digital leveling instruments can provide high accuracy measurements (Schwarz, 2002).
2. Easy to use: Digital leveling instruments are easy to use and require minimal training (Kavanagh, 2003).
3. Fast measurement: Digital leveling instruments can provide fast measurement results (Vaníček, 2005)

2.3.6 Limitations of Leveling Instrument

1. Limited Range: Leveling Instrument has a limited range, typically up to 1 km, which can make it less suitable for large-scale surveys (Kavanagh, 2003).

2. Collimation Error: Leveling Instrument requires precise collimation to ensure accurate measurements, which can be affected by instrument wear and tear (Schwarz, 2002).

3. Atmospheric Conditions: Weather conditions such as fog, rain, and extreme temperatures can affect the accuracy of Leveling Instrument measurements (Vaníuser, 2005).

4. Manual Data Entry: Leveling Instrument requires manual data entry, which can be time-consuming and prone to errors (Kavanagh, 2003).

2.4 Project Review

Total Station and Leveling Instrument are both effective instruments for height measurement, but they have different strengths and limitations. Total Station offers high accuracy and long-range capability, but is susceptible to atmospheric conditions and multipath errors. Leveling Instrument provides high accuracy over short distances, but has a limited range. Understanding the principles, accuracy, range, and limitations of these instruments is essential for selecting the most suitable instrument for specific applications.