

**TACHEOMETRY BUILDING SURVEY:  
A COMPARISON BETWEEN EDM VS  
PHOTOGRAMMETRY**

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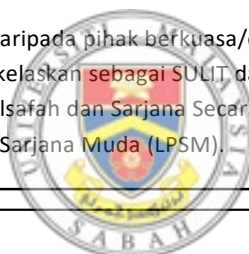
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## **ABSTRACT**

Building surveying plays a vital role in a building construction project where it helps to establish the location and leveling of the building. There are several types of building surveying method such as tacheometry surveying, LIDAR surveying, theodolite surveying, plane table surveying, compass surveying, and photogrammetry surveying. Among of them, photogrammetry surveying is a method that brings a lot of benefits to the surveyor in term of speed and effectiveness. However, the accuracy of the photogrammetry surveying has been questioned by engineers. Thus, in this project, the main objective is to develop a procedure of carrying out photogrammetry surveying to create a 3D model of the library of University Malaysia Sabah (UMS), Kota Kinabalu, Sabah. On behalf of this, a tacheometry surveying will also be being conducted on the same building by using total station to do a comparison with photogrammetry survey in term of accuracy. The comparison of accuracy between both surveying methods will be done by using the principle of root mean square error and standard deviation. Lastly, the result of analysis was analyzed and found out that the horizontal distance of the 3D model from photogrammetry survey was classified as Band J while the vertical distance was classified as Band H.



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## **ABSTRAK**

### **KAJIAN BINAAN TACHEOMETRI: PERBANDINGAN ANTARA EDM VS FOTOGRAMETRI**

*Ukur bangunan memainkan peranan yang sangat penting dalam projek pembinaan. Ukur bangunan digunakan untuk menetapkan lokasi dan menyemak kerataan bangunan. Terdapat pelbagai jenis kaedah ukur bangunan seperti tacheometri, LIDAR, teodolit, meja satah, kompas dan fotogrametri. Antaranya, kaedah ukur jenis fotogrametri merupakan kaedah yang membawa banyak faedah kepada juruukur dari segi kelajuan dan keberkesanan. Walau bagaimanapun, ketepatan kaedah ukur jenis fotogrametri telah dipersoalkan oleh jurutera. Justeru, dalam projek ini, objektif utama adalah untuk mengeluarkan satu prosedur untuk menjalankan kaedah ukur jenis fotogrametri untuk mencipta satu model 3D perpustakaan Universiti Malaysia Sabah (UMS), Kota Kinabalu, Sabah. Dengan ini, kaedah ukur jenis tacheometri juga akan dijalankan dengan bangunan yang sama dengan menggunakan stesen total untuk membuat satu perbandingan dengan kaedah ukur jenis fotogrametri dari segi ketepatan. Perbandingan ketepatan antara kedua-dua kaedah ukur akan dilakukan dengan menggunakan kaedah punca min kuasa dua. Akhir sekali, hasil analisis dianalisis dan mendapati bahawa jarak mendatar model 3D dari tinjauan fotogrametri diklasifikasikan sebagai Band J manakala jarak menegak diklasifikasikan sebagai Band H.*



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## **LIST OF CONTENT**

	<b>PAGE</b>
<b>LIST OF TABLES</b>	1 - 2
<b>LIST OF CHARTS</b>	2 - 3
<b>LIST OF FIGURES</b>	3 - 6
<b>LIST OF SYMBOLS</b>	7
<b>LIST OF ABBRECIATIONS</b>	8
<b>CHAPTER 1: INTRODUCTION</b>	
1.1 BACKGROUND OF STUDY	
1.1.1 HISTORY EVIDENCE OF SURVEYING	9 - 10
1.1.2 SURVEYING	11
1.1.3 CIVIL SURVEYING	11 - 13
1.1.4 CREATION AND EVOLUTION OF SURVEY INSTRUMENT	14 - 23
1.1.5 METHOD OF SURVEYING IN CIVIL ENGINEERING	24 - 27
1.2 PROBLEM STATEMENT	28
1.3 OBJECTIVES OF STUDY	28
1.4 SCOPE OF WORK	29
1.5 SIGNIFICANCE OF STUDY	30
<b>CHAPTER 2: LITERATURE REVIEW</b>	
2.1 BUILDING INFORMATION MODELLING (BIM)	31 - 32
2.2 TACHEOMETRY SURVEYING	32
2.2.1 METHOD OF MEASUREMENT	32 - 33
2.2.2 ERROR OF EDM	34 - 35





2.3 PHOTOGRAMMETRY SURVEYING	36
2.3.1 TYPES OF PHOTOGRAMMETRY	36 - 37
2.3.2 COMMON SOFTWARE FOR PHOTOGRAMMETRY	38 - 39
2.3.3 CAMERA CALIBRATION	39 - 40
2.3.4 IMPACT TOWARDS THE ACCURACY OF PHOTOGRAMMETRY	41 - 43
2.3.5 ACCURACY OF PHOTOGRAMMETRY: CASE STUDY	43 - 47
2.4 MEASUREMENT OF ACCURACY	47 - 48
2.5 SURVEY ACCURACY BANDING	48 - 49
<b>CHAPTER 3: RESEARCH METHODOLOGY</b>	
3.1 FLOWCHART OF METHODOLOGY	51 - 52
3.2 SURVEYING USING EDM METHOD	
3.2.1 APPARATUS	53 - 55
3.2.2 SOFTWARE	55 - 56
3.2.3 PROCEDURE	56 - 59
3.3 SURVEYING USING PHOTOGRAMMETRY METHOD	
3.3.1 APPARATUS	60 - 61
3.3.2 SOFTWARE	62
3.3.3 IMAGE ACQUISITION PLAN	62 - 63
3.3.4 OVERALL PROCEDURE	64 - 65
3.4 COMPARISON PROCESS	66
3.5 3D MODEL OF BEAR DOLL	67

## **CHAPTER 4: RESULT AND DISCUSSION**

4.1 OVERVIEW	68
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4.2 SELECTED BUILDING	68 - 70
4.3 PHOTOGRAMMETRY SURVEY (OBJECTIVE ONE)	70 - 78
4.4 TOPOGRAPHIC SURVEY USING EDM (OBJECTIVE TWO)	78 - 84
4.5 COMPARISON OF DATA (OBJECTIVE THREE)	
4.5.1 COMPARISON OF HORIZONTAL DISTANCE	85 - 90
4.5.2 COMPARISON OF VERTICAL DISTANCE	91 - 96
4.6 DISCUSSION	96 - 102
<b>CHAPTER 5: CONCLUSION</b>	
5.1 CONCLUSION	103
5.2 RECOMMENDATION	104
<b>REFERENCE</b>	105 – 109
<b>APPENDIX</b>	110 - 114



## LIST OF TABLES

TABLE		PAGE
TABLE 1.1	TYPES OF SURVEYING	12 - 13
TABLE 1.2	CREATION AND EVOLUTION OF SURVEYING INSTRUMENT	17 - 18
TABLE 1.3	HISTORY OF CAMERA	20 - 22
TABLE 1.4	HISTORY OF DRONE	23
TABLE 1.5	METHOD OS SURVEYING	24 - 27
TABLE 2.1	ERROR DUE TO MISALIGNMENT OF PRISM	34
TABLE 2.2	ERROR DUE TO TEMPERATURE	35
TABLE 2.3	COMPARISON BETWEEN PHOTOGRAMMETRY SOFTWARE	38 - 39
TABLE 2.4	CALIBRATION OF CAMERA OF SMARTPHONE POCO X3	40
TABLE 2.5	RESULT OF COMPARISON BETWEEN TAPE MEASUREMENT AND MODEL MEASUREMENT	44
TABLE 2.6	RESULT OF COMPARISON BETWEEN TAPE MEASUREMENT , SEMI-AUTOMATIC PHOTOGRAMMETRY AND AUTOMATIC PHOTOGRAMMETRY	46
TABLE 2.7	RESULT OF THE ACCURACY OF 3D MODEL (COMBINATION OF LIDAR AND PHOTOGRAMMETRY)	47
TABLE 2.8	SURVEY DETAIL ACCURACY BAND TABLE	48
TABLE 4.1	HORIZONTAL DISTANCE BETWEEN THE SELECTED POINTS	74 - 76
TABLE 4.2	HEIGHT FOR EACH SELECTED POINTS	76 - 78



TABLE 4.3	HORIZONTAL DISTANCE BETWEEN THE SELECTED POINTS	80 - 82
TABLE 4.4	VERTICAL DISTANCE OF THE SELECTED POINTS	82 - 84
TABLE 4.5	COMPARISON OF HORIZONTAL DISTANCE	85 - 87
TABLE 4.6	COMPARISON OF VERTICAL DISTANCE	91 - 93

## **LIST OF CHARTS**

CHART		PAGE
CHART 2.1	IMPACT TOWARDS THE ACCURACY OF PHOTOGRAMMETRY	41
CHART 2.2	GAUSSIAN DISTRIBUTION	48
CHART 3.1	FLOWCHART OF METHODOLOGY	51
CHART 3.2	DETAIL PROCEDURE IN PIX4D MAPPER	64
CHART 3.3	DETAIL PROCEDURE IN AUTODESK RECAP	65
CHART 3.4	DETAIL PROCEDURE IN AUTODESK REVIT	65
CHART 4.1	DEVELOPED PROCEDURE FOR PHOTOGRAMMETRY SURVEY	70
CHART 4.2	HORIZONTAL DISTANCE OF EACH CONTINUOUS POINTS	88
CHART 4.2	REGRESSION ANALYSIS (HORIZONTAL DISTANCE)	89
CHART 4.4	NORMAL DISTRIBUTION GRAPH OF DIFFERENCE BETWEEN THE MEASURED HORIZONTAL DISTANCE BY EDM AND PHOTOGRAMMETRY	89
CHART 4.5	VERTICAL DISTANCE OF POINTS BY EDM AND PHOTOGRAMMETRY	94



CHART 4.6	REGRESSION ANALYSIS (VERTICAL DISTANCE)	95
CHART 4.7	NORMAL DISTRIBUTION GRAPH OF DIFFERENCE OF VERTICAL DISTANCE BETWEEN EDM AND PHOTOGRAMMETRY	95

## LIST OF FIGURES

FIGURE		PAGE
FIGURE 1.1	PHYRAMID OF GIZA	9
FIGURE 1.2	MOSUL MESOPOTANIA IRAQ	10
FIGURE 1.3	SCRIBE DJESERKARESENEB CARRYING OUT A SURVEY OF THE CROPS	10
FIGURE 1.4	MAYA'S CUBIT	14
FIGURE 1.5	TRIANGULAR LEVEL	15
FIGURE 1.6	HAN DYNASTY MAGNETIC COMPASS	15
FIGURE 1.7	THE GROME- ANCIENT ROMAN EARTHMOVING TOOL	16
FIGURE 1.8	PLANE TABLE	17
FIGURE 1.9	THEODOLITE	19
FIGURE 1.10	TOTAL STATION	19
FIGURE 1.11	DAGUERREOTYPE	20
FIGURE 1.12	FIRST HAND-HELD CAMERA	21
FIGURE 1.13	KOTAK CAMERA	21



FIGURE 1.14	LEICA CAMERA	21
FIGURE 1.15	POLAROID CAMERA	22
FIGURE 1.16	DIGITAL CAMERA	22
FIGURE 2.1	3D MODEL OF DEPARTMENT OF CIVIL ENGINEERING	43
FIGURE 2.2	3D MODEL OF BARUTANA	45
FIGURE 2.3	BEAUFORT CASTLE	45
FIGURE 3.1	TOTAL STATION (1)	53
FIGURE 3.2	TOTAL STATION (2)	53
FIGURE 3.3	OPTICAL SURVEY PRISM (1)	54
FIGURE 3.4	OPTICAL SURVEY PRISM (2)	54
FIGURE 3.5	LASER DISTANCE METER	55
FIGURE 3.6	AUTODESK REVIT 2021	55
FIGURE 3.7	CHECKING ERROR OF TOTAL STATION	57
FIGURE 3.8	REMOTE ELEVATION MEASUREMENT (REM)	58
FIGURE 3.9	OFFSET SURVEY	59
FIGURE 3.10	CANON EOS 600D	60
FIGURE 3.11	DJI MAVIC AIR 2	61
FIGURE 3.12	SOFTWARE OF PHOTOGRAMMERY	62
FIGURE 3.13	TECHNIQUE IN TAKING PHOTO OF EXTERIOR BUILDING	63
FIGURE 3.14	TECHNIQUE IN TAKING PHOTO OG EXTERIOR BUILDING (EABLE VIEW)	63
FIGURE 3.15	3D MODEL OF BEAR DOLL	67



FIGURE 4.1	DISTANCE OF MAIN CAMPUS LIBRARY FROM KOTA KINABALU TOWN	69
FIGURE 4.2	BUILDING OF LIBRARY UNIVERSITY MALAYSIA SABAH	69
FIGURE 4.3	3D MODEL OF LIBRARY UMS GENERATED IN PIX4D MAPPER	71
FIGURE 4.4	QUALITY CHECK OF THIS MODEL FROM PIX4D MAPPER	71
FIGURE 4.5	THE CAMERA POSITION	72
FIGURE 4.6	ORIENTATION UNCERTAINTIES	72
FIGURE 4.7	POINT CLOUD OF THE BUILDING IN AUTODESK REVIT 2023	73
FIGURE 4.8	BOUNDARIES OF BUILDINGS	73
FIGURE 4.9	POSITION OF TRANSFER POINTS, SELECTED POINTS AND SHOOTING DIRECTION	79
FIGURE 4.10	BOUNDARIES OF BUILDINGS WITH NUMBERING OF EACH SELECTED POINTS	79
FIGURE 4.11	3DMODEL OF LIBRARY UMS IN AUTODESK REVIT	79
FIGURE 4.12	BUILDING PARTS THAT BLOCKED BY OBSTCLES (1)	97
FIGURE 4.13	BUILDING PARTS THAT BLOCKED BY OBSTCLES (2)	97
FIGURE 4.14	BUILDING PARTS THAT BLOCKED BY OBSTCLES (3)	98
FIGURE 4.15	IRREGULAR SURFACE OF THE CONNECTION BETWEEN UPPERWALL TO THE ROOF (1)	98
FIGURE 4.16	IRREGULAR SURFACE OF THE CONNECTION BETWEEN UPPERWALL TO THE ROOF (2)	98
FIGURE 4.17	3D model created with different angle and height (1)	99
FIGURE 4.18	3D model created with different angle and height (2)	99
FIGURE 4.19	3D model created with different angle and height (3)	99



FIGURE 4.20	3D model created with different angle and height (4)	99
FIGURE 4.21	FAILED 3D MODEL	100
FIGURE 4.22	ERROR DUE TO THE GAP BETWEEN THE WALL AND PRISM	101
FIGURE 4.23	COORDINATE OF THE TOTAL STATION	101





## LIST OF SYMBOLS

H	HEIGHT
mm	MILLIMETER
km	KILOMETER
m	METER
°	DEGREE
$\sigma$	SIGMA
X	ERROR
N	NUMBER OF ERROR
$\mu$	MEAN OF ERROR



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## **LIST OF ABBREVIATIONS**

EDM	ELECTRONIC DISTANCE MEASUREMENT
UAV	UNMANNED AERIAL VEHICLE
BIM	BUILDING INFORMATION MODELLING
RICS	ROYAL INSTITUTION OF CHARTERED SURVEYORS
LIDAR	LIGHT DETECTION AND RANGING
AEC	ARCHITECTURE, ENGINEERING AND CONSTRUCTION
RMSE	ROOT MEAN SQUARE ERRORS
NGS	NATIONAL GEODETIC SURVEY
DSLR	DIGITAL SINGLE-LENS REFLEX CAMERA
REM	REMOTE ELEVATION MEASUREMENT
GSD	GROUND SAMPLING DISTANCE
RCP	AUTOCAD RECAP



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# CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

#### 1.1.1 History Evidence of Surveying



**Figure 1.1: Pyramids of Giza**

Source: National Geographic

Surveying is most likely to have originated in ancient Egypt. The Great Pyramid of Khufu at Giza, which is 755 feet (230 meters) long and 481 feet (147 meters) high, was erected in 2700 BCE. Its near-perfect squareness and north–south orientation attest to the ancient Egyptians' surveying prowess.



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**Figure 1.2: Mosul Mesopotamia Iraq Air View of River Tigris Mosul**

Sources: Shutterstock

Besides that, the rich valleys and plains of the Tigris, Euphrates, and Nile rivers have evidence of some type of border surveying dating back to 1400 BCE. Sumerian clay tablets provide land measuring data as well as city and agricultural area designs. Land plot boundaries have been protected by preserving boundary stones. (John Brock, 2019)



**Figure 1.3: Scribe Djoserkareseneb carrying out a survey of the crops**

Source: OsirisNet 2001

On the side of a tomb at Thebes (1400 BCE), a picture of land measurement depicts head and rear chainmen measuring a grainfield with what seems to be a rope with knots or markings at uniform intervals. Many people are seen. According to their clothes, two of them are of great status, most likely a land supervisor and a border stone inspector. (John F. 2005)

### **1.1.2 Surveying**

The practice, profession, art, and science of identifying the terrestrial or three-dimensional locations of points, as well as the distances and angles between them, is known as surveying or land surveying. A land surveyor is a person who works in the field of land surveying. They are working on the points that are usually found on the Earth's surface and are frequently used to create maps and boundaries for ownership, locations, such as the designed positions of structural components for construction or the surface location of subsurface features, or other government or civil law-mandated purposes, such as property sales. Geodesy, geometry, trigonometry, regression analysis, physics, engineering, metrology, computer languages, and the law are all worked by surveyors.

### **1.1.3 Civil Surveying**

Civil engineering is a difficult field to master. Apart from military engineering, it is the second-oldest engineering subject with a wide range of features. It is a type of engineering that entails analyzing and documenting information about a specific region of land. (Philip Kosky,2013) These findings can subsequently be utilized to aid in the planning and for the success of construction projects range from infrastructure to residential and commercial buildings. In civil engineering, surveying is used to discover the three-dimensional connections between various sites. Engineers will use the information such as lengths and angles between points and lines to determine how to develop plans for public buildings, residences, roads, bridges, and other types of construction and infrastructure projects. Engineers will measure the points on the earth's surface, or they may also be found the points in space. Civil surveying incorporates components of other disciplines, such as mathematics, geography, and law, since complicated, accurate spatial connections and boundary lines are so important to this process. Civil surveying also necessitates the use of specialized equipment and satellite-



based GPS data. For precise measurements, high-precision electromechanical and optical equipment is also required.

Civil survey is beneficial in a wide range including:

- Planning new construction projects
- Creating topographical or marine navigational maps
- Planning paths for roads, railways, power lines, water supply lines and others
- Identifying the boundaries of properties
- Determining land ownership
- Identifying the location of existing infrastructure
- Creating 3D modeling of structure
- Charting navigational routes

There are several types of civil engineering surveys which are construction surveying, deformation surveying, geological surveying, hydrographic surveying, and topographic surveying.

**Table 1.1: Types of Surveying**

Construction Surveying	Construction surveying is important for evaluating the layout of buildings, roads, electricity lines, gas mains, and other infrastructure in the vicinity of possible construction sites. By analyzing the data, the planning of a construction project will be easier.
Deformation Surveying	Deformation surveying is used to determine if a geographical or man-made feature is changing shape, such as a road, foundation, shoreline, or river. Engineers record the three-dimensional coordinates of specific sites in deformation surveying. They will re-record the coordinates after some time to see if both data have any differences in terms of magnitude. A



	comparison of the two data sets can tell whether there has been any deformation or displacement.
Geological Surveying	Rivers, valleys, mountains, and other physical elements of the terrain are all mapped out via geological surveying. For geological surveying, satellite data is crucial, and engineers commonly use the satellite data or aerial images to aid them in their job.
Hydrographic Surveying	Hydrographic surveying focuses on determining the location of coasts. The Coast Guard and marine rescue operations are working on the navigational maps that is created by hydrographic surveying. It does help the conservationists in the management of the coastal resources.
Topographic Surveying	Topographic surveying examines a landscape's form and physical characteristics. Engineers measure the elevation of various geographical locations and then construct contour lines to show areas of similar elevation. These data may subsequently be used to develop topographical maps and analyze topography for future construction or infrastructure projects.



#### 1.1.4 Creation and evolution of Survey Instruments

Surveying and mapping instruments have progressed from the compass and chain, through transits and tapes, to optical-reading theodolites, electronic distance measuring equipment, aerial photogrammetry, and finally to high-speed computers, the global positioning system, robotic total station instruments, digital photogrammetry, and satellite remote sensing systems. (Paul R. Wolf, 2002)

##### a. Ancient Surveying Instrument



**Figure 1.4: Maya's Cubit (18<sup>th</sup> Dyn., Louvre Museum, N 1538)**

Source: Photo courtesy of Alain Guilleux

In Ancient Egypt, surveying is very important in establishing the boundaries to check for ownership of the fields. Egyptians use Cubit Rod for distance measuring. Cubit Rod is a type of rod that made up from wood, slate, or stone with markings to show the subdivisions. The units that are used in Cubit Rod are Digits, Palm and Cubit. Cubit is based on the length from the bent elbow to the tips of the fingers; Palm is based on the width of the palm of the hand; Digits is based on the width of a human finger. The measurement was set as four Digits are equal to one Palm while seven Palms are equal to one Cubit. As 100 Cubit are joined together, it comes out with another Rods named Cord. (Fr. Monnier, 2016)