TACHEOMETRY BUILDING SURVEY:

A COMPARISON BETWEEN EDM VS PHOTOGRAMMETRY

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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.

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 takeometri, 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 mengunakan stesen total untuk membuat satu perbandingan dengn 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 fotogrammetri diklasifikasikan sebagai Band J manakala jarak menegak diklasifikasikan sebagai Band H.

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LIST OF SYMBOLS

H	HEIGHT
mm	MILLIMETER
km	KILOMETER
m	METER
°	DEGREE
σ	SIGMA
X	ERROR
N	NUMBER OF ERROR
μ	MEAN OF ERROR

LIST OF ABBREVITIONS

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

CHAPTER 1

INTRODUCTION

1.1 Background of Study

1.1.1 History Evidence of Surveying

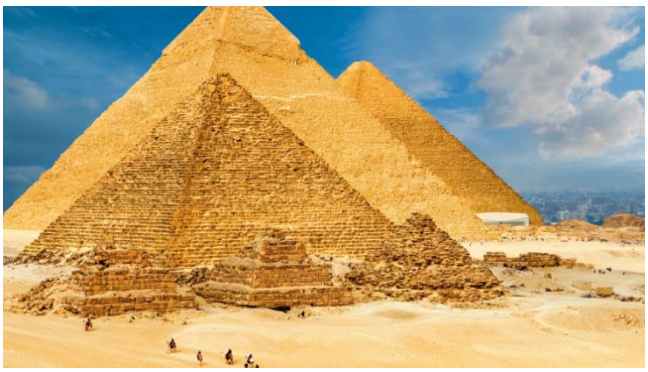

Figure 1.1: Pyramids of Giza

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.

Figure 1.2: Mosul Mesopotania 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 Djeserkareseneb 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 a several types of civil engineering surveys which is 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 projects 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 term 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 (18th 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 uses 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 is 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 fingers. 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)