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Research Article

Mapping the Musamus University Campus Using the Bm Tie Point at Mopah Merauke Airport

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Abstract. Musamus University is one of the state universities located in the easternmost region of the archipelago, which is currently under construction. In the current era of development, the availability of maps is something that cannot be left behind, especially for the physical development of facilities and infrastructure, as progress in the field of science and technology is so rapid. Measurement and mapping work is an integral part of civil engineering work planning or building design. This writing needs to be done in order to provide correct information, the presence of information will be used to plan something. Likewise, mapping vehicles can not only be carried out terrestrially, but also photogrammetrically, and even propagate in space with satellite technology with various advantages. Each vehicle has advantages and disadvantages so it really depends on the mapping, the level of detail of the objects that must be presented, and the coverage of the area to be mapped. And the methodology that the author uses in this study is the Literature methodology and the Observation Methodology. Surveys and mapping were carried out on the Musamus University campus and its supporting infrastructure, the results of the calculation are as follows: top thread = 1550m, middle thread = 1300m, bottom thread = 1050m, optical distance = 50m, flat distance = 49.98m, height difference = 1.51m and angle correlation = 0°1’26’’.

Keywords: *Survey, Mapping, Musamus.*

A. INTRODUCTION

Geometry is a subset of a broader science called geodesy. Geodesy has two purposes, namely scientific purposes, determining the shape of the earth's surface and practical purposes, making a shadow called a map of most or a small part of the earth's surface (Malone et al., 2022; Zeraatpisheh et al., 2020).

This second purpose is often referred to as mapping. Measurement and mapping can basically be divided into 2, namely Geodetic Surveying and Plan Surveying. The principle difference between the two types of measurement and mapping above is that Geodetic surveying is a measurement to describe the earth's surface in a curved/ellipsoidal/spherical plane (Ma et al., 2019; Liang et al., 2019). Geodetic Surveying is the science, art, technology for presenting information on the shape of the earth's curvature or on the curvature of the sphere. Meanwhile, plan surveying is a science, art, and technology to present the shape of the earth's surface, both natural and man-made elements on a plane that is considered flat. In making maps, known as mapping can be achieved by making measurements on the surface of the earth that has an irregular shape (Arrouays et al., 2020; Teng et al., 2019).

Measurements are divided into horizontal measurements to obtain a relationship between the points measured above the earth's surface (Horizontal Baseline Measurement) and vertical measurements to obtain a vertical relationship between the measured points (Vertical Baseline Measurement) and point measurements -point details (Batjes et al., 2020; Chaney et al., 2019). The basic mapping framework for civil engineering work in a small area, so that the earth can still be considered a flat plane, is generally a part of the measurement and mapping work of a single package of civil engineering building planning and/or design work. The points of the basic mapping framework, which will be determined first, their coordinates and elevations, are made evenly distributed with a certain density, permanent, easily recognizable and well documented so as to facilitate further use (Brogi et al., 2019; Ballabio et al., 2018).

In the era of regional autonomy, all potential resources, both human resources (Sosekbud) and natural resources (physical) in the region, need to be developed so that they can be used optimally. For that we need a good planner, implementation in accordance with the plan, supervision and monitoring in each managed field (Wadouz et al., 2019).

In order to guarantee legal certainty, land that has been measured and registered in the implementation of land registration in principle must be mapped on a registration map/map, registration basis or other map that meets the requirements for scale and planimetric accuracy. The mapping activity begins with the creation of a map framework in the form of the National Cadastre Basic Framework (KDKN) so that the cadastral mapping system or large-scale registration map creation is in a single and integrated framework system.

The technical base point in the field of land registration is defined as a point that has coordinates obtained from a measurement and calculation of a certain system that functions as a binding point for map preparation purposes (Zeraatpisheh et al., 2020). When viewed from the needs related to the availability and function of the technical base point which is very important, the measurement and mapping of the technical base point basically requires a technological breakthrough that can produce precise coordinate data and allows measurement and mapping work to be carried out quickly, effectively and efficiently.

B. LITERATURE REVIEW

1. Determination of Measurement Points

This fixed point consists of triangulation points and polygon points. Triangulation points are made of concrete pillars and are installed in large areas/mountains or on each island. Polygon points are made of concrete pillars and are installed in small areas, such as in cities or industrial and residential areas (Nguyen et al., 2020).

While the temporary point is a sign that is temporary, both in its manufacture and use in measurement. Temporary dots consist of: a) Pegs, these tools are made of wood or bamboo, which are used to mark temporary boundaries at the time of measurement. This point is planted into the soil to a depth of 0.25 – 0.50 meters. The stake is inserted into the ground by hitting it and the rest that sticks out from the ground is 5 to 10 cm. it is recommended that these tools be marked with red paint for easy visibility; and b) Yalon, Yalon is made of iron/wooden pipe with a diameter of inch which is used to mark the point/limit of measurement and is temporary. To make it easy to see, this tool is colored red and white alternately. In order not to be damaged quickly, due to being stuck into the ground, the bottom is equipped with iron shoes (Tumsavas et al., 2019).

2. Determination of Height Difference

To measure the difference in height between two points can be done in several ways as follows: a) The plane stands on one of the measured points; b) The plane stands between the two measured points; and c) The plane stands outside the two measured points. Meanwhile, to measure the difference in height between more than two points can be done in several ways as follows: 1) The rise and fall method (rise and function method); b) The height of collation method; and c) Based on the presence or absence of a fixed point (BM) at the measurement location, this measurement system is divided into:

The methods that can be used to determine the coordinates of a point or several points are as follows, namely determining the coordinates of a point by binding forward at a certain point. What is measured are the angles at the fastening point. Fastening to the front is done by means of the Theodolite standing on a point/peg whose coordinates are known and a measuring sign is placed above the point whose coordinates are to be known; and by tying it back at a certain point. What is measured are the angles that are at an indeterminate point. Back binding is done by: Theodolite stands at a point whose coordinates are unknown, the target/measurement marker is erected on a peg whose coordinates are known (Behrens et al., 2018; Brus, 2019).

While determining the coordinates of more than one point is to create a polygon. The points are located lengthwise and are combined with each other to form a polygon (polygon), and by making a shape with triangles. The points are joined to each other to form a triangle (Keskin et al., 2019). The polygon method is used when the points to be searched for coordinates are located elongated so that they form a polygon. From this polygon, the coordinates of the points must be calculated, for that it is known by the formula:

$$X_2 = X_1 + d_{12} \sin \alpha_{12}$$
$$Y_2 = Y_2 + d_{12} \cos \alpha_{12}$$

It takes a definite x and y (x1 and y1); the distance between two points 1(x1, y1) and 2 (x2, y2) where x2 and y2 are calculated by x1, y1 the distance d12 and the angle along the line 12, 12. Then the polygon must begin with a point whose coordinates are known and to determine the direction angles of the sides of the polygon, it must be used at the starting point, which has been determined, while the distances between the polygon points are measured directly.

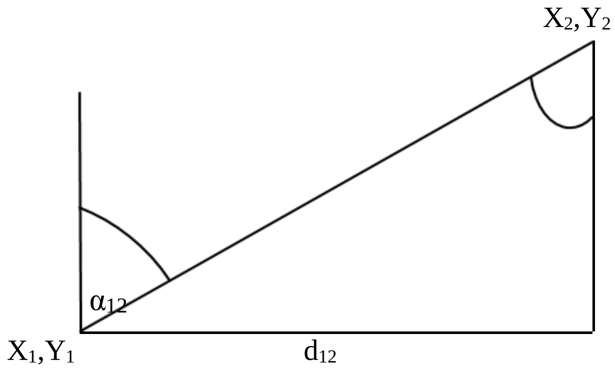

Figure 1. Determining the Coordinates of a Point

3. **Angle Measuring System**

The angle measurement system consists of the following parts:

a. Sexagesimal angle measurement system

The sexagesimal angle measurement system is presented in degrees, minutes and seconds. Do not call the angular second unit the second, because the second is better used for the unit of time.

The sexagesimal method divides a circle into 360 parts called degrees, so that one quadrant has 90 degrees. One degree is divided into 60 minutes and one minute is divided into 60 seconds. In other words, one degree (1°) equals sixty minutes (60'), one minute (1') equals sixty seconds (60”), thus one degree (1°) equals three thousand six hundred second (3600”). Or written as follows : 1° = 60’ 1’ = 60” 1° = 3600”

b. Sentimental Angle Measuring System

The system of centimetric angles is presented in grid, centigrid and centicentigrid quantities. The centimetric method divides a circle into 400 parts, so that one is called a grid (Dai et al., 2019). One grid is subdivided into quadrants having 100 sections that are 100 centigrids and 1 centigrid is subdivided into 100 centigrids. It can be written as follows :

1g = 100c
1c = 100cc
1g = 10000cc

This sentisisimal method is gradually overriding the sexagesimal method, because for measurement, moreover, the calculation of the sentimental method is easier to use than the sexagesimal method. However, even so, the sentisimal method cannot replace the sexagesimal method entirely, because in astronomy, geography still uses the sexagesimal method for determining the time, longitude and latitude of places on the earth's surface.

c. Angle Size Conversion

The quantities of different angle systems can be converted from one system to another. The approach to converting it is the value of the angle in one turn. In one turn the angle value is equal to 360 degrees or 400grid or 2π radians. Thus, if we are going to use a measuring and mapping tool that has an angle gauge, both horizontally and vertically, then we must first examine the angle system that we use for the tool we use (Padarian et al., 2019).

Closed polygons are polygons whose starting and ending points are one. This kind of polygon is the most preferred polygon in the field because it does not require a lot of binding points which is difficult to find in the field, but the results are quite controlled in size (Dematte et al., 2019). Because the shape is closed, it will form a polygon or n segment (n = the number of polygon points). Closed polygons provide checks at certain angles and distances, a very important consideration. The first vertex = the last vertex

Closed polygons are usually used for measuring contour points, centralized civil buildings, reservoirs, dams, UPI campuses, settlements, bridges (because they are isolated from 1 place), land ownership and framework topography.

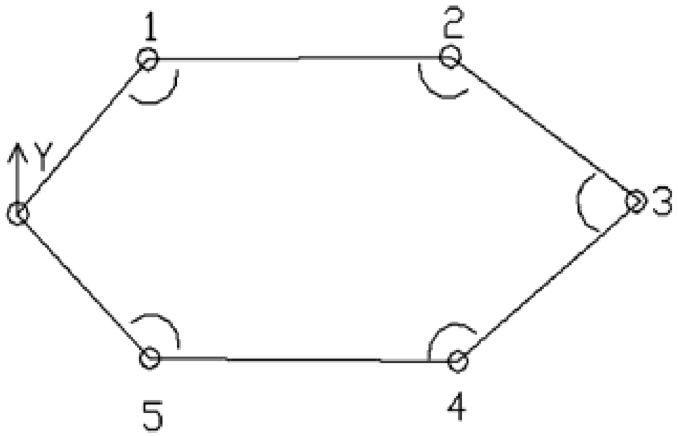

Figure 2. Closed Polygon

The steps for calculating this polygon are as follows:

a. Add up all the angles of the polygon.
b. Calculate angle correction:
   $V\,\beta = (n\text{-}2).180 - (\sum)$ ... (Angle β inside)
c. Divide the correction by all angles:
   $Vi = VB / n$

If one side of the polygon is known, for example 12, then the azimuth of the other side can be calculated as follows:

$\alpha 23 = \alpha_{12} = + \beta_2 + V_2 - 180°$
$\alpha 34 = \alpha_{23} = + \beta_3 + V_3 - 180°$
$\alpha 45 = \alpha_{23} = + \beta_4 + V_4 - 180°$
$\alpha 56 = \alpha_{45} = + \beta_5 + V_5 - 180°$

$\alpha 67 = \alpha_{56} = + \beta_6 + V_5 - 180°$
$\alpha 71 = \alpha_{71} = + \beta_7 + V_7 - 180°$

As a control is calculated as follows: $\alpha_{12} = \alpha_{71} + \beta_1 + V_1 - 180°$ must be equal to α_{12} already known. An important discussion especially for perfectly bound polygons both closed and open. A perfectly bound polygon is a polygon that is bound by two points at the beginning of the measurement and two points at the end of the measurement, each of which already has the definitive coordinates of the previous measurement results. The value of the inner or outer angles as well as the horizontal distance between the polygon points are obtained or measured from the field using angle measuring tools and distance measuring instruments that have a high level of accuracy (Shahid et al., 2018).

4. Polygons Bound Only to Beginning and End Coordinates

If a polygon is bound at the beginning and end, respectively, at points A and B, whose coordinates are known but whose azimuth is not known, the condition can be solved in two steps. The first step is to determine the initial azimuth taken by approach or measured with a compass.

5. Compass Polygon

In theodolite polygons all the angles are calculated. These angles will be used to find the direction or azimuth angles of the sides of the next polygon. However, on an angle measuring instrument that has used a compass, in every direction that is targeted, the angle of direction (azimuth of the compass) will be read (Lamichhane, 2019).

6. Graphic Polygon

If a polygon has known its angles, directions and distances, its depiction can be done by first calculating the coordinates of the polygon points, or also drawn directly from the Major Angle (azimuth) data with a protractor and from distance data with a scal rule. The drawing of the last polygon is called a graphic polygon.

7. Knot Polygon

In polygons made of three fixed points (which have certain coordinates) or more and meet at one point, the meeting point of the polygons is called the vertex or common point.

C. METHOD

1. Work Implementation

Before conducting a survey, there are several things that must be considered in identifying the data to be carried out during the survey. The data that will be needed is the direction (angle) and distance according to the research objectives. The equipment and materials needed for the survey are: 1) Compass, to obtain orientation data (angle); 2) Measuring tape, to get data and distances; 3) Pegs for marking the measurement location points; 4) Jalon for temporary marking of the point to be measured; 5) GPS; 6) Theodolites; and 7) Stationery for the purposes of making sketches in the field.

GPS (Global Positioning System) equipment is used for determining reference coordinates through measurements if available. If it is not available, you can use the starting point of observation from the bench mark monument (BM) belonging to Mopah Merauke Airport whose coordinates have been obtained. The research location takes place on the Musamus University Campus.

2. Measurement Method

The measurement method used is terrestrial measurement, which is direct measurement using the soil survey method. There are several measurement techniques carried out, for example distance measurement. If the distance of the aiming point from the observation point exceeds the length of the measuring tape, then the technique of making a straight line in the field is known.

The stages that will be carried out in this research activity are as follows: 1) Preparation Stage, this stage consists of identification and formulation of problems and determination of research objectives, literature study related to the research title; 2) Testing stage for measuring instruments, at this stage testing tools are carried out to find out to what extent the tool is functioning properly and correctly so that the measurement results obtained can be known to the level of accuracy; 3) Data Collection Phase, Data is data that is directly taken at the research location, namely the coordinates of the points of making the network using a theodolite tool; 4) Data Processing Phase, At this stage, processing of existing data is carried out for further analysis of the results. The process of this stage is the processing of the theodlite size results and terrestrial surveys (polygons). In the survey data processing process, the coordinates of the measurement results are obtained (Gallo et al., 2018).

D. RESULT AND DISCUSSION

1. Result

Soil surveying or surveying is the determination of the position of points on or near the earth's surface where processing and depiction are carried out by assuming the earth's surface as a flat plane. From this description it can be concluded that the activities in soil surveying include: 1) Data collection (process of obtaining data from the field); 2) Data processing; and 3) Presentation of data/images.

Data collection is the process of getting data from the field, its implementation is based on certain rules. Data processing is the process of processing data. This requires knowledge of mathematics such as analytical geometry and trigonometrics.

Data presentation is the process of presenting data, one of which is a map. This map must be able to provide correct information. The truth of the information will be used as material for planning something. While geodesy includes a broader study and measurement, not only mapping and positioning on land, but also on the seabed for various purposes, as well as determining the shape and size of the sea dimensions of the earth both with measurements on the earth and with the help of aircraft, as well as with satellites and their information systems.

The purpose, scope, environment and vehicle for the presentation are different, therefore the discipline of surveying can be classified into several fields of study, namely: 1) geodetic surveying; b) plane surveying; c) topographic surveying; d) cadastral surveying; e) engineering surveying; f) mine surveying); g) hydrographic surveying; h) photogrammetric surveying; and i) radargrammetric surveying. Geodetic surveying includes determining the shape and size of the earth, the gravitational field and creating a mapping contour network. His activities here also extend to a few things about astronomy and near-satellite positioning.

The results of calculations and steps in data processing are as follows:

BA = Retrieved from Thread Reading = BT + (BT – BB)
BT = Retrieved from Thread Reading =(BA + BB) / 2
BB = Retrieved from Thread Reading = BT - (BA – BT)
STA PO Starting Point

Tool Height : 1417m
Vertical Angle : 88°24’10’’

STA PO – P1

Tool Height : 1417m
Chain Distance : 50 m
Sign reading Ba = 1550
Bt = 1300
Bb = 1050

Top Thread Correlation:
Bt+(Bt - Bb)=1300+(1300 – 1050) = 1550m

Middle Yarn Correlation:
(Ba+Bb)/2 = (1550+1050)/2 = 1300m

Bottom Yarn Correlation:
Bt-(Ba - Bt)=1300-(1550 – 1300) = 1050m

Optical Distance :

$$=\frac{(Ba - Bb) \times 100}{1000}$$

$$= \frac{(1550 - 1050) \times 100}{1000}$$

$$= 50m$$

Vertical Angle : 88°24'10''
Major Angle (azimuth) : 307°30'0''

From the meter in the field, it is known as horizontal measurement so that from the results of the measurement it can be known as follows:

Flat distance = Tilt distance x Sin vertical angle
= 50.00 x Sin 88.403
= 49.98m

To find out the results of the calculation of the height difference can be obtained as follows :

The formula for the height difference is:

Height difference = Tool height – (Middle thread reading + (optical distance x cosα vertical angle).

Tool Height : 1417m
Chain Distance : 50 m
Bt sign reading = 1300
Optical distance : 50.00
cosα vertical angle : 88.403
= 1412 – (1300 +((50.00 x 1000) x cos88.403)
= 1.51m

For the calculation of the distance abscissa and ordinate can be seen as follows:

From the two examples of calculations used data from the results of measurements in the field, it can be seen as follows:

Abscission = flat distance x sinα azimuth angle
Optical distance: 50.00
cosα vertical angle : 88.403
= 49.98 x 307.50
= - 39.65 m

Ordinate = tilt distance x cosα azimuth angle

= 49.98 x cos 307.50
= 30.43m
Point Height = Starting point + Height difference
= 10 + 1.51
= 11.51m

Polygon conditions can be obtained by the following formula:
Geometric conditions:
I α end – α beginning I=∑β – (n-2) x 180°
I α cd – α abI =(∑β – kβ)- (n-2) x 180°
Abscission requirements :
Xend– Xbeginning = ∑d sin α
α = α + K β /n
Xc – Xa = ∑d cos α
Xc – Xa = ∑d cos α + KX
Ordinate Terms :
Y end – Y beginning = ∑d cos α
Yc – Ya= ∑d cos α + Ky
Kβ = - fβ / nβ

Closed Polygon Measurement Calculation
STA PO – P1
Tool Height : 1345m
Chain Distance : 50 m
Sign reading Ba = 1570
Bt = 1286
Bb = 1002
Top Thread Correlation :
(2 - Bt)-Bb = (2 x 1286) – 1002 = 1570m
Middle Yarn Correlation :
(Ba+Bb)/2 = (1570+1002)/2 = 1286m

Bottom Yarn Correlation:
(2 x Bt)-Ba = (2 x 1286) – 1570 = 1002m
Optical Distance :
=(Ba – Bb) x 100
1000
= (1570 – 1002) x 100
1000
= 56.8m

Vertical Angle : 90°0’0’’
Major Angle (azimuth) : 228°40’40''
Inner angle correlation :
∑β = (n-2) x 180°
= (16-2) x 180°
= 2520°
Inner angle correlation Δβ :

$$(2520°00'00'')-(2520,042)$$
$$= 0°1'26''$$

Correlation of outer angle:

$$\sum\beta = (n+2) \times 180°$$
$$= (16+2) \times 180°$$
$$= 3240°$$

Inner $\Delta\beta$ correlation :

$$= (3240°00'00'')-(3239°58'33'')$$
$$= 0°1'26''$$

2. Discussion

Plane surveying includes measurements in a limited area so that the effects of the curvature of the earth's surface can be ignored and the calculations can be directly referenced on a flat plane. For this reason, the control points used are the junction of the geodetic control points, as is the case in soil surveying from engineering surveys (buildings, bridges, tunnels). Photogrammetric surveying (photogrammetric surveying) covers aspects of measurement and mapping from aerial and terrestrial (ground) photos, remote sensing techniques and photo interpretation. The subjects include: planning, physical aspects of photography, equipment, analog and analytical integrated systems, remote sensing, photo interpretation and holography.

The subject of radargrammetric surveying is the same as that of photogrammetry, the only difference is the wavelength used and the sensor. In radargrammetry using microwaves with active sensors. Topographic surveying (topographic surveying) is the mapping of the physical earth's surface and the appearance of human culture. Relief elements are presented in the form of contour lines. The map scale ranges from 1:500 to 1:250,000 with contour line intervals between 0.25-100 meters. Maps of this type that are larger than 1:2500 in scale are called engineering maps and those without contour lines are called plan.

Cadastral surveying is a measurement to determine the position of land ownership boundaries, mapping of land parcels for registration of land rights and for legal certainty of land acquisition (certificates), as well as mapping for land and building taxes (PBB) or physical cadastral. Engineering surveying includes large-scale topographical mapping as the basis for engineering planning and design such as roads, bridges, buildings, flyovers and dams. Mine surveying includes special techniques needed to determine the positions and projected images of objects, both underground (in underground mining) and on the earth's surface (open pit mines). Hydrographic surveying is concerned with surface and underwater areas, consisting of two branches, namely: 1) Offshore surveys; 2) Survey near the coast.

The implementation of surveys and mapping on the Musamus University Campus is one form of knowing the location and condition of the campus. So that people are more familiar with and know the location of the Musamus University campus, so that this will be discussed and analyzed in the data obtained in surveys and mapping in the field. The results obtained from the measurement and processing of field data are the heights at the measured points (pegs) for the purposes of depiction in mapping. Calculations include: 1) Correcting the measurement results; 2) Reducing the measurement results, for example reducing the inclined distance to a horizontal distance and so on; 3) Calculate the azimuth of solar observations; and 4) Calculate the coordinates and elevation of each point.

E. CONCLUSION

Based on the discussion and calculation results above, it can be concluded that: 1) Based on the results of the angle correlation calculation, the results are the same so that the measurement is declared good; 2) For the implementation of the coordinates/polygon point measurements use theodolite because the angle readings will be more accurate, but for height difference measurements use a spirit level; and 3) From the results of the mapping of the musamus university campus, it is concluded that the layout of the campus is no longer in accordance with the initial planning.

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