INTEGRATION ANALYSIS OF DRONE MULTI SENSOR-GNSS-LIDAR-CAMERA FOR 3D MAPPING (CASE STUDY: PT GARAM, PAMEKASAN, MADURA)

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ABSTRACT

Every year salt was carried out by PT Garam twice whereas the previous process used the method of terrestrial and manual calculations with sacks. Therefore, a map of salt production is needed using the Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) sensor navigation system to increase the data's accuracy level. Unmanned Aerial Vehicle applications for the purpose of obtaining geometric documentation results and for capturing textures that characterize object structures. (Adamopoulos, 2020). LiDAR can classify based on the number of image acquisitions processed in the software, utilizing photogrammetric, and structural science principles from Motion technology. (Fernández, Hernandez et.al 2015) LiDAR Acquisition process that enables the creation of point clouds, three-dimensional models, and Digital Surface Models with high accuracy. (Barba, et al. 2019). A three-dimensional model makes it easy for users to choose a virtual position on the map, has good accuracy in interpreting the map, and displays a more real shape. LiDAR has a disadvantage in the form of coordinate data positions that have local references. (Cahyadi., et al. 2019). Unmanned Aerial Vehicle (UAV) technology has the advantage of efficiency in the cost and time of data collection. These researchers use multi-sensor technology GNSS, LiDAR, and Drones to map the stockpile of salt on open land and in warehouses. makes it easy to calculate the area of salt land and calculate the volume of salt production. This was done for PT GARAM to meet the community's needs and monitor the amount of salt production. This data can be used as a reference for digital asset inventory and the system can be applied to optimize the salt industry. The drones used in this study are the DJI Matrice 300 and the Low-Cost Drone Tarot Iron Man 650. Both types of drones are used to measure land and salt volume. The end product of the research is in the form of data generated in the form of a point cloud to calculate the salt stockpile volume and the elevation level of the salt land area.

Keyword: LiDAR, Salt, and Unmanned Aerial Vehicle

Introduction

PT. Salt (Persero) is a state-owned company engaged in salt production in Indonesia as an industry that produces the availability of national salt. PT. Salt, located on Madura Island, has an area of around 5,600 hectares spread across Sumenep Regency and Pamekasan. Optimization of salt production is needed because salt needs are related to various sectors. PT Garam has obstacles in the process of monitoring salt production. That is because salt is monitored and calculated manually with the help of sacks. The method has many shortcomings in the form of inefficient time in calculating salt and the data accuracy level. Another method used to calculate the volume of salt is to use a total station. However, the tool has a shortage in terms of time efficiency because every point aim to require the mobilization of human resources in order to get accurate results. Therefore, in this study, UAV was used to accelerate the monitoring of salt land as a basis for conducting production calculations. This step is carried out because the area of salt land is directly proportional to salt production. In addition, UAVs make it easy to measure in areas with broad coverage and high mobility. However, measurements with UAVs still have not answered the need to optimize salt production due to a lack of data accuracy to determine the elevation of salt land. The elevation is known to determine the distribution of land contours to optimize salt land production. Therefore, in this study, the integration of Lidar and UAV was carried out to make more effective measurements than the conventional methods that have been carried out. As for the GNSS tool, it is used to help UAV positioning when flying in the air. This measurement requires manufacturing salt production maps using the Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) sensor navigation system.

Based on (Shao Zhenfeng, 2021), theoretically, the UAV platform (Unmanned Aerial Vehicle) and the mobile mapping vehicle platform can be equipped with high-temporal, high-spatial, and high-spectral resolution. UAV is used for remote sensing applications for urban areas as observation material achieved by building appropriate models or algorithms based on spatial, spectral, and shape features. Therefore, research was conducted by LiDAR using Pixhawk to integrate with the GPS. Based on the journal (Malberg, 2022), the measurement of salt stockpile volume can be done using LiDAR. The LiDAR uses a type of rotation Velodyne 30 degrees, 7 times the acquisition time, and 10 times the scanning length. The measurement method still has to adjust to the size and area to acquire some data en masse. Based on the data (Malberg, J.A 2022) obtained from the results of the camera acquisition, the next step is forming a digital surface model. Photo grids will be used as validation data with a grid area of 0.1 x 0.1 meters. This study uses a 360 Go Pro camera as a surface-matching material to adjust the shape of the existing salt stockpile. Lidar data acquisition has an estimated time of under 15 minutes. LiDAR can conduct classifications based on the number of image acquisitions processed in software, utilizing photogrammetry principles and motion technology structures (Fernández., et al., 2015). The LiDAR acquisition process allows the manufacturing of cloud points, and 3D models, with high -form density and accurate images. (Barba., Et al 2019). After the GPS measurement coordinates are obtained, georeferencing is carried out to integrate with the geographical information system. Lidar data obtained are processed in the Global Mapper application and Cloud Compare. The volume calculation process using conventional measurements in terrestrial methods requires a long time and an enormous cost. Therefore, this research uses a combination of sensors such as GNSS Low Cost and LiDAR. GNSS Low Cost serves to give a position value to the observed object. Meanwhile, integrated LiDAR is used for 3D data collection for mapping purposes by getting the results of cloud points in coordinates X, Y, and Z. These results are then processed to determine the height at the measurement location.

LiDAR has a deficiency in terms of data coordinate positions obtained that have local references. Therefore, GPS helps determine the position of the data obtained to increase accuracy and get good data quality in terms of precision and accuracy. The main advantages of GNSS low-cost technology are the it hase geodetic type's quality. (Cahyadi., Et al 2019). GNSS technology, more commonly called the Global Positioning System technology, is a coordinate acquisition tool that produces latitude, longitude, time, and height data in scientific units on earth. (Taufik., Et al 2019) GPS Low-Cost technology experiences significant development at a low cost and a little use of energy, including producing data quality that has an accuracy equivalent to geodetic GPS. (Taufik., Et al 2019) The need for data acquisitions with GPS technology with the availability of more economic tools is inversely proportional because GPS technology has a price of around 2000 USD (Yuwono., et al., 2019). The GNSS-Mimu integration technique has been developed, such as by adding additional sensor tools in the form of pixhawk. The tool can make a three-dimensional model, making it easier for users to find the map's virtual position and better accuracy. The UAV application is used to get the results of geometric documentation and capture the texture that characterizes the object's structure. (Adamopoulos, 2020).

This study will calculate the volume and land stockpile of PT. GARAM in Pamekasan Regency. The drone has a maximum flying height of 120 meters from the surface and is integrated with the GNSS-LiDAR sensor to achieve accurate, fast, and inexpensive missions. In the research that will be conducted, UAV data will be used to calculate the volume of the land stockpile of PT. GARAM. The development of UAV, GNSS, and LiDAR technologies, combined into one newest technology to cover each other's deficiencies, aims to increase the accuracy of calculating the volume of PT. GARAM. LiDAR volume measurement validation data with elevation measurements using a Total Station and Waterpass. This study provides an overview of the comparative analysis of Multi-Sensor Drone measurements with conventional terrestrial measurement methods with GPS and Total Stations reviewed through the time of measurement and the costs used in the period of taking the salt stockpile data that has been determined. This method speeds up the process of calculating the volume and stockpile of salt land both inside and outside the Warehouse. PT. Garam has 200 warehouses at the beginning and 200 at the end of the year, so this method is expected to speed up the stockpile evaluation completion process at PT Garam.

Methodology

This study used a Multisensor Drone to measure salt fields and calculate salt volume. The UAVs used consist of the DJI M300 and the Tarot Iron Man Drone for data acquisition. IPAD LiDAR technology is used to compare data with RP LiDAR A1 and Livox MID-40. The data used as validation is a triangular measurement in the form of Low-Cost GNSS and Total Station. In addition, there is supporting data, such as the results of interviews with PT GARAM partners. The following is a flow chart of the measurement methods that have been carried out.

Early stage

In the early stages, two activities were carried out in the form of field orientation and determining the measurement area. Field orientation aims to determine the characteristics of the land being measured. The next activity is determining the measurement area to determine the object's boundaries and the characteristics of the land being measured. In addition to getting to know the measurement area, the two activities were carried out to determine the measurement boundaries and the measurement method to use.

1. **Measurement Stage**
   Salt Land measurements are carried out in the warehouse with an estimated time of 1 week of data acquisition. Data validation was compared between the Low-Cost Drone Multi-sensor measurement results with the Terrestrial Total Station and LiDAR IPAD methods. Photogrammetry + LiDAR measurements are carried out by utilizing the Low-Cost Drone RTK instrument, which is integrated with the LiDAR device. This measurement aims to obtain coordinate data and obtain point clouds recorded by LiDAR devices. These measurements were made to calculate the volume of the salt stockpile. The GNSS data recording was carried out to obtain validation coordinate values that are spread over the salt land measurement area. The method used in recording data using GNSS is the static method with the concept of net measurement and the Real Time Kinematic method for correcting the measurement results of the DJI M 300 LiDAR Livox MiD 40 Drone. Terrestrial measurements were carried out using a total station. This measurement aims to obtain the volume of salt in the warehouse, which will be used as a comparison value from the value obtained from photogrammetry + LiDAR measurements. IPAD measurements were carried out to obtain LiDAR data, coordinates, and three-dimensional visualization. Measurements using IPAD are carried out by circling the object to get the results of measuring the salt stockpile volume.
2. **Data Analysis Stage**
   The analysis stage is carried out to carry out measurement data validation tests between various methods. Primary data is the result of measurement, and secondary data is the result of validation from PT Garam Pamekasan. The georeferencing process is carried out to adjust the data results to the base map. In volume measurement, validation is carried out in the form of measurements using the terrestrial method in the salt cellar. Data distribution analysis used the standard deviation method to do filtering data signal outages. Field measurements and salt stockpile volumes used the RMS Error method to test the level of accuracy compared to the validation data.

IMU (Inertial Measurement Unit)

The Inertial Measurement Unit (IMU) is an inertial navigation system that became known in 1950 and is more accurate for terrestrial navigation purposes (Morton, 2021). An IMU equipped with a base navigation computer is called an INS (Inertial Navigation System). In this study, researchers used IMU because the data acquisition location was indoors, and the drone was flown manually. In addition, the use of IMU indoors plays a role in providing position information because the GPS signal indoors is weaker than in an open area. According to Groves (2008), the IMU generally consists of 2 sensors: the accelerometer and the gyroscope. Some

IMUs were developed incorporating additional inertial sensors to protect against single-sensor failure, but these sensors are more subject to inaccuracies due to temperature variations and bias (Jose, 2009). The specific force is the difference between the actual acceleration in space and the acceleration due to gravity, so the resulting acceleration is linear. The gyroscope is used to measure the orientation of a moving vehicle by providing an output in the form of angular velocity. The acceleration and speed information generated by the IMU can then be translated into position information, although this position information is less accurate than GPS (Groves, 2008). IMU is used to keep the drone able to fly indoors. In the Low-Cost Drone, there is a Pix Hawk type 2.4.8, which is used so that the quadcopter can fly stably. The tool is connected to Garmin GPS to help position the drone while flying. In addition, Pitch, Roll, and Yaw data are used to correct the position of the LiDAR object. The correction was made during the post-processing of the salt volume measurement results. Altitude, Longitude, and Latitude values are converted to UTM coordinates first. Before calculating, the LiDAR position rotated 90 degrees due to adjusting the LiDAR position during acquisition with Low-Cost drones. If the translation and rotation processes are not carried out during the object acquisition process, only the drone's flight path data can be plotted.

Algorithm

Precision and Accuracy

Several terms are used to describe measurement reliability, namely precision, accuracy, and uncertainty (Mikhail and Gracie, 1981). GNSS receiver requires a large area to receive signals from the satellites it tracks. If the receiver's line of sight to the satellite is blocked by objects such as buildings, trees, bridges, and other objects, the receiver cannot receive signals from the satellite. So the receiver cannot calculate its position or time. The solution for signal outages/blockage is the receiver tracking more than one constellation, or the user can integrate a GNSS receiver with several navigation sensors, such as an IMU. IMU can assist in bridging signal outages/blockages, such as those caused by objects such as buildings, trees, bridges, and others, and also in recovering GNSS signals after signal outages/blockages (Novatel inc, 2020). Precision is defined as the degree of closeness of repeated measurements to the same object. Accuracy is indicated by the spread of the data distribution. The smaller the distribution, the higher the accuracy, and vice versa. The usual size is the standard deviation. The higher the accuracy, the smaller the standard deviation value, and vice versa. Accuracy is the degree of closeness of the measurement results to the correct value. Correctness is not only the result of random error but also the bias that exists due to uncorrected systematic error. The precision value can be indicated by the standard deviation value of measurement and the Root Mean Square Error (RMSE) of the processed data. Accuracy tests were carried out to determine the accuracy of land measurements and the volume of salt stockpile made and were carried out based on each three-dimensional model space. The following is the formula for calculating equation 2.1 from the Root Mean Square Error (RMSE):

$$\mathbf{RMS}=\sqrt{\frac{\sum_{i=1}^{n}(X_{model}-X_{validation})^2}{n}} \quad \mathbf{(2.1)}$$

Explanation:

- $xmodel$ = Values on salt field measurement results
- $xvalida$tion = Value on total station validation data
- N = Lots of measurement samples

Based on the data processing results, there is a Standard Deviation Analysis to determine the distribution of data. Standard Deviation analysis is performed to filter data that experience data outages. Standard Deviation analysis is carried out while processing Salt Stockpile volume data. The following is the formula for equation 2.2 to calculate the standard deviation:

$$\mathbf{Deviation\ Standard}=\sqrt{\frac{\sum_{i=1}^{n}(pop-pop\ average)^2}{n}} \quad \mathbf{(2.2)}$$

Explanation:

- n pop = The number of samples of measurement of Low-Cost Drone coordinates
- pop average = The results of the calculation of the average measurement results of Low-Cost Drones

Area Geometry

The area geometry accuracy test is carried out based on the standard error percentage value of less than 2% based on the Technical Specifications of the Regulation of the Minister of Agrarian Affairs (PMNA), Head of the National Land Agency (BPN) Number 3 of 1997 concerning tolerance of different percentages of land area. The formula used to calculate the percentage of area geometric errors is as follows:

$$\%\ \text{wide difference error} = \frac{x_{model}-x_{validation}}{x_{validation}} \times 100\% \quad \mathbf{(2.3)}$$

Explanation:

- Xmodel = value in a three-dimensional model
- Xvalidation = value on validation data

Research sites

The construction of a multi-sensor drone using UAVs for land mapping on PT Garam's land aims to obtain altitude data. In addition, multi-sensor drones were also tested for 3D modeling. The objects that will be examined in this activity are several areas in PT Garam's land, especially in Pamekasan Regency. This location has coordinates 7.20055, 113.54906. The volume data acquired is in the Salt Transit Warehouse, with an area of 20 x 40 meters with an estimated height of 8 meters. The Transit Warehouse can accommodate around 2000 tons of salt.

Figure 1. Research Site

Measurement Data

Measurement data consists of validation data and measurement results data. The measurement results contain volume LiDAR Drone Data and PT Garam Pamekasan Stockpile Land. The validation data be composed of Raw Low-Cost GNSS measurement data and Total Station Measurement Result Data. Additional measurements were carried out to increase the variety of data using IPAD 2021. In addition, there are Secondary Data in the form of interview results from partners of PT Garam.

Low-Cost Drone Multi-Sensor

The Tarot 650 Iron Man drone is equipped with a payload system to carry payloads in the form of multi-sensors consisting of GNSS, LIDAR, and low-cost IMU LiDAR quadcopter-type drones that are more adaptive in maneuvering. The drone is equipped with a payload box with a larger payload capacity than the low-cost drones that have been on the market before. This capacity allows the drone to carry multiple sensors at once.

Figure 2. Low-Cost Drone LiDAR Multi-Sensor

Based on Figure 2. GNSS sensor and RP LiDAR A1, the payload is also equipped with an IMU sensor and gimbal to support accurate positioning. LiDAR data acquisition is carried out between the two legs of the multi-sensor drone with a range of 140-220 degrees. Low-Cost Drone Components assembled:

1. Devices: bldc motor, esc, flight controller, GPS, USB, telemetry, transmitter, receiver, propeller, and 4s battery
2. Data acquisition range: Logitech c270 camera, maximum flight altitude of 12 meters, and 8 cm LiDAR detection capability
3. Estimated Price: 21,000,000
4. LiDAR file legend: Time; rolls; pitches; yaw; altitudes; latitude; longitude; compass; data Lidar (angle ranges 140-220)
5. Data Acquisition: Each corner has 2 data, so, at a measurement of 140-220 degrees (80 degrees), there are 160 data for each data collection.

RPLIDAR A1M8-R6 is a type of LiDAR that has an object scanning sensor using a 2D laser beam with a 360-degree angle. This LiDAR technology can scan within 12 meters and have a 360-degree angle range. The resulting data is in the 2D form, which can be used for mapping, localization, and environmental modeling. The RPLIDAR A1 scan frequency reaches 5.5 Hz and can scan up to 360 samples per round, and the frequency can be set up to a maximum of 10 Hz. The RPLIDAR A1 operates well in all types of indoor and outdoor environments without sunlight.

DJI Matrice 300 and LiDAR Livox MID 40

The DJI M300 Drone sensor is integrated with the LiDAR Livox MiD 40 and the camera via the payload. The payload system can carry a Livox MID 40 lidar sensor. Then a trial of the DJI M300 was carried out to bring the existing payload according to the CNC design. LiDAR Livox MID 40 has an acquisition design to map the surrounding environment. Point Cloud provides detailed measurements in the form of a circular laser with a data acquisition center. Mid-40 equals a 32-line point cloud product when the integration time is 0.1 seconds. Data acquisition can provide an area sweep with a data frame range of 3000 m/s.

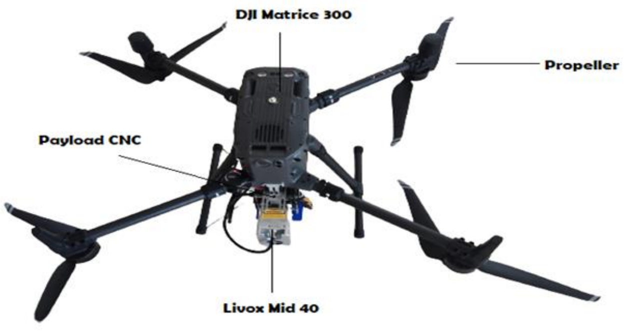

Figure 3. Payload Design on DJI M300 and LiDAR Livox

The Livox Mid-40 LiDAR sensor can detect objects as far as 260 meters. LiDAR uses a sophisticated circular scanning pattern to provide highly accurate details. The LiDAR MID 40 is already in mass production and ready for immediate delivery to facilitate use in autonomous driving, robotics, mapping, security, and other areas.

Result and Discussion

Table 1. Number of Volume Measurement Points

Total Station	IPAD LiDAR	Low-Cost Drone LiDAR
43 points	1048576 points	1170 points

The measurement of Salt Stockpile Volume is carried out by measuring three methods. The terrestrial method is carried out with a Total Station, and the UAV method is with a Low-Cost Drone. IPAD measurements were carried out as supporting data for the two methods that have been carried out. The measurement time for the total station method is 1-hour, Low-Cost Drone 15 minutes, and LiDAR IPAD 15 minutes. The most measurement points were obtained from LiDAR measurements of 1048576 points, and the lowest point was the terrestrial method with 43 points. This is because each method has a different measurement capacity according to the needs of measuring the salt stockpile volume.

Based on the obtained visualization of the measurements carried out using the Total Station, IPAD, and Low-Cost Drone methods. The volume resulting from terrestrial measurements is 724.383044 cubic meters, with a validation value to be used as a reference for actual data. The red color represents GNSS acquisition data when measuring volume. At the same time, the light blue color is validation data using the Terrestrial measurement method using the Total Station tool. IPAD measurements are used as additional data in volume measurements.

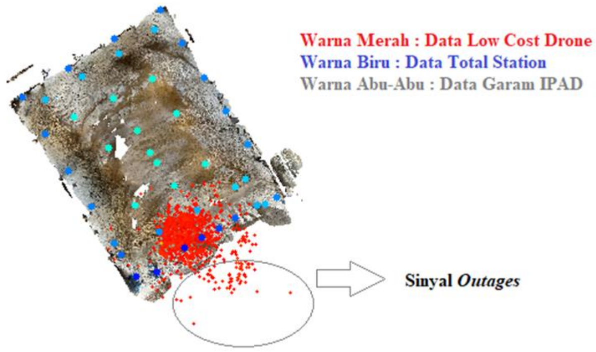

Figure 4. Overlapping of Volume Measurement Results

Table 2. Results of Volume Standard Deviation Analysis

Results of Volume Standard Deviation Analysis	IPAD LiDAR Standard Deviation	Standard Deviation of LiDAR Low-Cost Drones
Easting: 7.635	Easting: 2.667	Easting: 2.664
Northing: 8.734	Northing: 2.347	Northing: 2.247
Z: 1.6586	Z: 1.878	Z: 1.833

In table 2, a statistical test is carried out on the measurement volume. The standard deviation is used to determine each data distribution level. The data is used to perform filtering outages that occur in measurements. The distribution of the Low-Cost Drone data is to help with volume calculations. Based on LiDAR measurements, IPAD has a volume of

720.23167 cubic meters. At the same time, the lowest value is obtained from the measurement value of the Low-Cost Drone of 324,688 cubic meters. Low-Cost Drone measurements have the most significant difference due to signal outages during the data acquisition. LiDAR data retrieval is not comprehensive from the Stockpile form due to the narrow space between the Stockpile and the roof of the building.

Table 3. RMS Volume Measurement Error

RMS Error	**RMS Error value**	**Difference Between Methods**
Result of RMS Error between Total Station and IPAD	0.822496 meter	TS+IPAD – TS+Drone= -3.104
RMS Error Results between Total Stations and Low Cost Drones	3.92697 meter	TS+Drone-Drone+IPAD= 2.383
RMS Error Results between Low Cost Drones and IPAD	1.54346 meter	Drone+IPAD-TS+IPAD=0.7209

In table 3, to find out the RMS Error Validation value is done to check the accuracy between methods. The method used as a reference during the georeferencing process is the terrestrial method. Measurement of the RMS error results between the total station and IPAD has better results because the value is smaller than the other methods. These results are due to the volume of data acquisition between Total Station and IPAD does not have problems in the form of signal outages.

Georeferencing

Figure 5. Georeferencing

Georeferencing is a process of labelling coordinates in the form of positional calibration of raster data in the form of images. These coordinates are obtained from the measurement results of Salt Land as reference data. Livox MID 40 data which still has local coordinate data from a measurement, becomes a global coordinate system. This method is used to integrate all local observation data into one coordinate system. Georeferencing uses the reference point of the Low-Cost GNSS measurement results. Geographical data needs to be aligned with the coordinates of the measurement results that have been carried out so that they can be exactly in the Satellite Image data.

In Figure 6. RMS Error 4.801 is generated, which is processed in the Cloud Compare application. The RMS error value, which has a small value, is said to be more accurate than the estimation method, which has a more significant Root Mean Square Error (RMSE). The RMS Error measurement is used to evaluate the results of data retrieval of the results of linear regression measurements of salt lands by measuring the accuracy of the estimates of a model.

Table 4. Comparison of Area of Salt Land Measurement Results

Parameter	**GNSS Low Cost**	**LiDAR Livox MID 40**
Salt Land 2400 Square meters	2550 Square Meters	2542 Square Meters

Measurement validation was carried out by calculating the area of 15 x 80 meters of salt land for one salt field. Salt field measurements produce Low-Cost GNSS data with manual calculations having a difference of 150 square meters. This is because the salt fields do not have a fixed land area because they are built in a semi-permanent form, so they are easily affected by the weather. The difference in the form of the Low-Cost GNSS with the LiDAR Livox MID 40 is quite significant due to the difference in reference between the two. LiDAR Livox MID 40 data have a local reference, and Low-Cost GNSS has a WGS 84 reference converted to UTM 49 S coordinates. In addition, the data objects detected by the LiDAR Livox MID 40 are only two salt fields. The measurement error data for salt land has a better correction value of 5.91%. Measurements with LiDAR Livox MiD-40 have a better level of accuracy because LiDAR data can map the topography in more detail. LiDAR has absolute and relative accuracy for better modelling and more realistic interpretation. This is used during acquisitions, such as calculating the height of objects and sorting out land boundaries and the surrounding water.

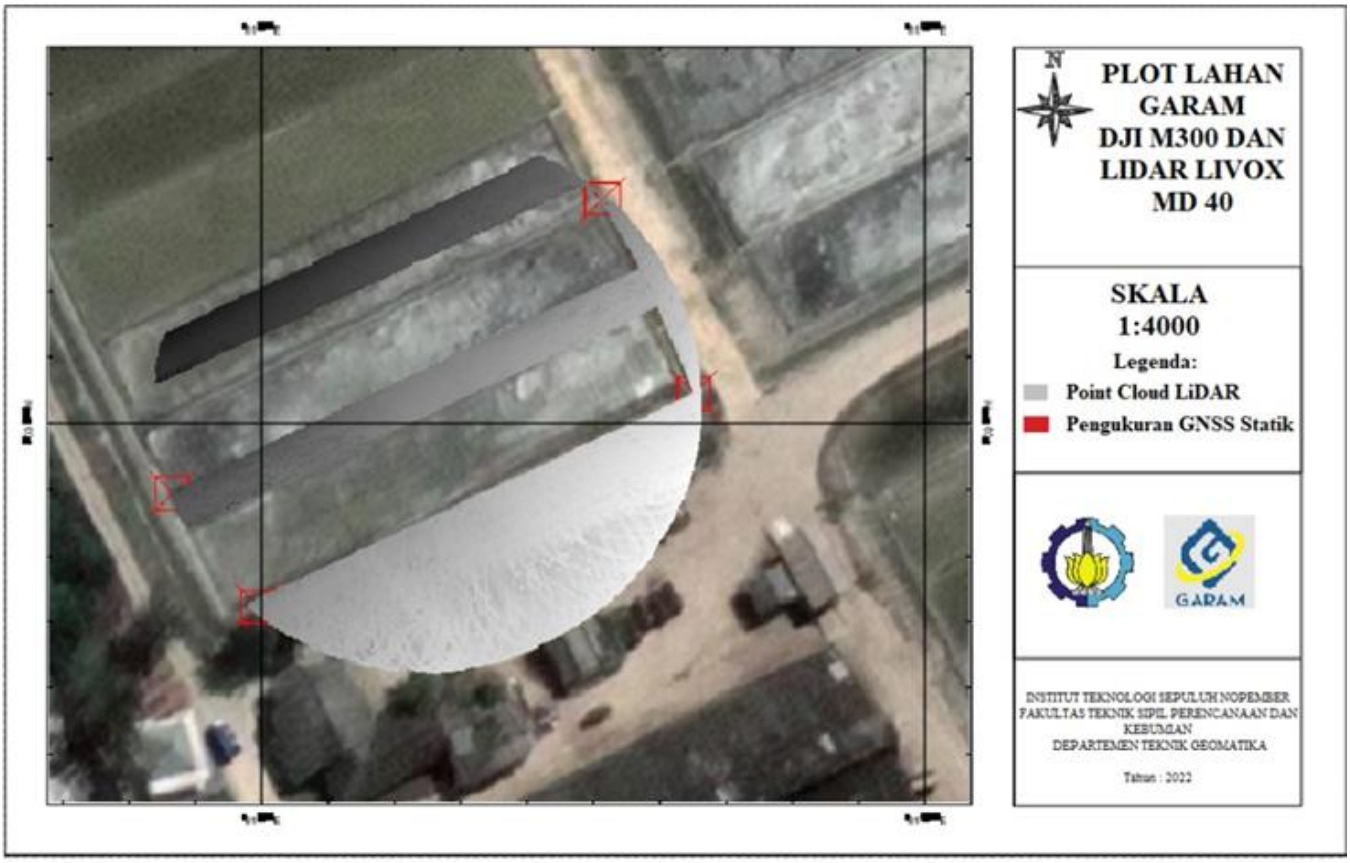

Figure 6. Georeferencing Position Figures

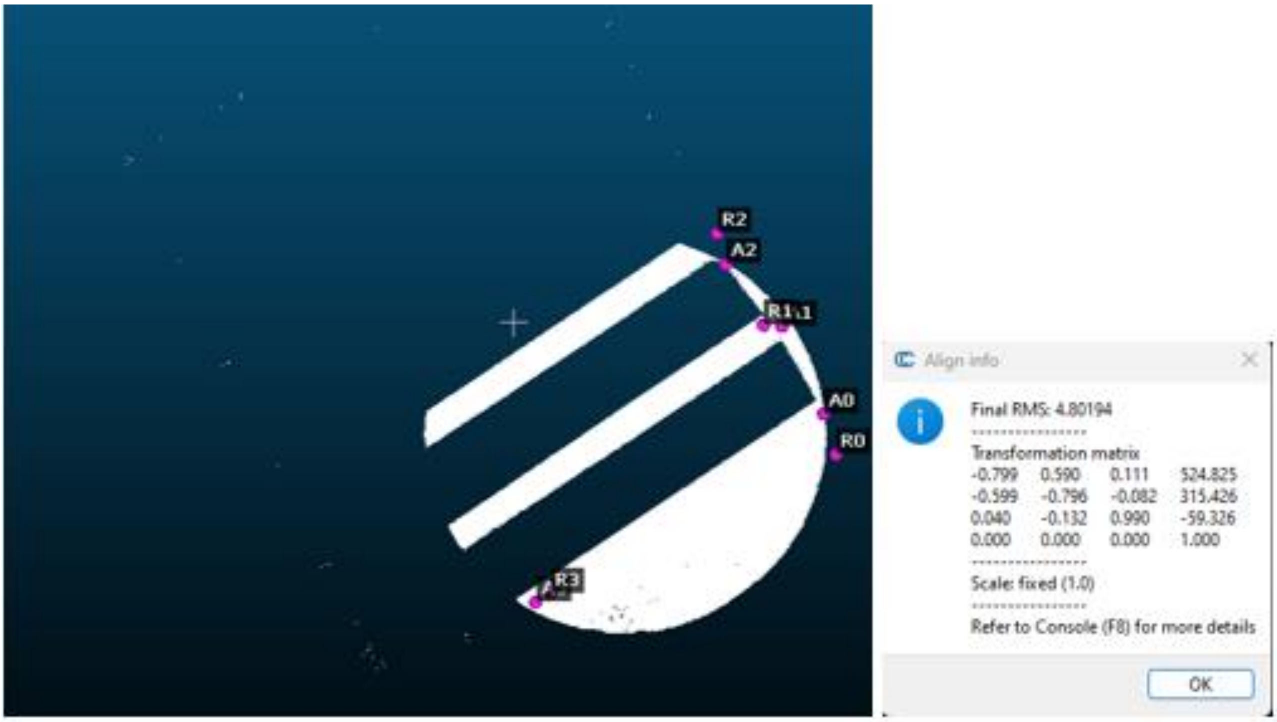

Figure 7. Comparison Results of Root Mean Square Error Total Station with LiDAR Livox MID 40

Table 5 shows the results of the area geometry accuracy test carried out based on a standard error percentage value of less than 2%. This calculation was carried out with a value of 5.91% for the LiDAR Livox MiD 40 accuracy test. This is because LiDAR Livox MID 40 measurements have better quality point cloud data than Low-Cost GNSS data.

Table 5. Standard Level of Measurement based on Land Area

Low Cost GNSS	LiDAR Livox MID 40
6.25 %	5.91 %

Table 6. Number of Salt Land Acquisition Result Points

Number of IPAD Points	Number of Low cost GNSS Points	Number of Livox MID 40 points
8139611 points	28 points	1974360 points

Conclusion

Researchers can conclude that making a three-dimensional visualization of PT. Salt for measurement efficiency has not been optimally carried out. Volume Low-Cost Drone has a small volume value due to the use of LiDAR, which can only process the coverage area of only one point cloud line. Besides that, drones are still unstable to fly statically to retrieve data optimally. The analysis process for modelling accuracy test results was carried out using three methods: height correction, area error correction, and volume correction. Volume Correction has a different value of 399,694 meters3 between the Total Station and the Low-Cost Drone. This is because there is poor data acquisition to produce salt stockpile areas. In addition, there are many signal outages because the measurements are carried out in the Warehouse. The measurement error data for salt land has a better correction value of 5.91%. Measurements with LiDAR Livox MiD-40 have a better level of accuracy because LiDAR data can map the topography in more detail. LiDAR has absolute and relative accuracy for better modelling and more realistic interpretation. This is used during acquisitions, such as calculating the height of objects and sorting out land boundaries and the surrounding water.

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