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Results of Coal Run of Mine Volume Calculations Based on Geodetic GPS Data at PT. Victor Dua Tiga Mega

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Abstract: This study aims to calculate coal volume in the Run of Mine (ROM) area at PT Victor Dua Tiga Mega using Geodetic GPS and the cut and fill method. Geodetic GPS measurements produced 2,016 elevation points, which were processed into contours with a 1-meter interval and a Digital Elevation Model (DEM). Volume calculation was performed by comparing the initial and final surface models to determine elevation differences (ΔZ) across the stockpiles. The total calculated volume was 170,915.146 m³, which was converted to tonnage using a coal density of 0.96 ton/m³, resulting in 164,078.540 tons. Compared to the weighing data of 160,766.433 tons, the deviation was 2%, within ASTM's 2.78% tolerance. The results indicate that Geodetic GPS provides accurate, efficient, and reliable measurements for coal volume estimation, offering significant time and cost savings while maintaining high precision for large-scale mining operations.

Keywords: *Coal, Deviation, Geodetic GPS, Cut and Fill.*

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I. INTRODUCTION

Mining activities are activities carried out to extract minerals through several stages, starting from exploration to the management of mineral production. One of the most widely used minerals is coal, which is a primary energy source widely used in the electricity, manufacturing, and other sectors. In coal mining, it is necessary to ensure operational efficiency, stock data, and coal supply, especially in the Run Of Mine (ROM) area [5]. Volume calculations to determine coal production for a month are carried out by surveys. Calculations using the cut and fill method are the industry standard for calculating the material extracted, with models of the surface before and after excavation activities.f elevation measurement points in both techniques. This issue is not only related to work efficiency but also concerns the reliability and consistency of survey results.

Currently, coal stockpile measurement methods have developed conventionally. Conventional measurement tools such as Total Stations have long been the standard in volume measurement due to their high precision, especially in detailed measurements and confined spaces. However, the development of real-time Geodetic GPS systems based on the Global Navigation Satellite System (GNSS) offers higher efficiency with modern and short timeframes, without requiring many control points [2]. Both commonly used tools, Geodetic GPS and Total Station, share the same objective of generating a digital model or Digital Terrain Model, which may result in different ROM volume values [10]. The sensitivity of the cut and fill method to surface modeling errors can influence the elevation measurement points in both measurements. This not only relates to work efficiency but also concerns data reliability and the consistency of measurement results [3].

In the context of mining operations, differences in volume results between scales are something that needs to be considered, as they can lead to errors in production reporting, stock control, and even affect the performance evaluation of work units if they are not identified objectively. Therefore, a data-based comparative study is needed to calculate the measurement results of volume measurements with Geodetic GPS systematically and scientifically using the cut and fill method.

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II. EASE OF USE

A. GPS Geodetic

Geodetic GPS is a satellite-based surveying instrument used to determine precise real-time positions on the Earth's surface. Real-Time Kinematic (RTK) is a satellite-based positioning technique that provides high accuracy in real time through differential processing of phase data. The real-time system can be applied to determine the position of both stationary and moving objects, enabling Real-Time Kinematic systems to perform not only real-time GPS surveys but also high-precision navigation [8].

B. Total Station

A Total Station is a land surveying instrument used to automatically measure distances and angles (both horizontal and vertical), equipped with internal memory that allows data to be stored and processed using a computer [9]. The Total Station employs prism and laser methods, along with digital readings, to measure angles and generate X, Y, and Z coordinates, making it a more modern surveying instrument compared to the theodolite [4].

C. Cut and Fill Method

The Cut and Fill method is a highly important technique in surveying and earthwork volume calculations for construction projects [7]. This method involves the processes of excavation (cut) and embankment (fill) to achieve the planned ground surface elevation. It is applied across various fields, including residential area development on uneven terrain as well as mining operations [7].

In the present research, Cut and Fill volume calculation is performed using the composite volume method, where each Cut and Fill surface requires two different ground surfaces: the original surface and the design surface [11]. The Cut and Fill method can accurately calculate volumes in such areas by comparing two surfaces with different shapes and elevations [6].

III. METHOD

A. Research Location

The research was conducted at PT Victor Dua Tiga Mega, located in Luwe Hulu Village, North Barito Regency. PT Victor Dua Tiga Mega is a coal mining company that has obtained a production permit and operates with a focus on coal extraction. The study was carried out in January at the stockpile (stock ROM) area. Coal measurements were performed on eight (8) individual stockpiles within the area.

B. Data Processing

Conducting a literature study by reviewing previous relevant research on measurements using Real-Time Kinematic Geodesy that will support this research. Studying the calculation of coal volume to tonnage. Studying how to calculate stockpile volume using surveys and how to use the software. Studying the calculation of deviation and how to use coal tonnage deviation.

Conducting field data collection activities related to the research title. Using a Geodetic GPS e-survey device with a real-time system. Data collection was carried out at PT. Victor Dua Tiga Mega in the ROM area, with measurements taken on raw coal in several blocks. Installation of a base for the Geodetic GPS and installation of a Bench Mark Total Station were performed. Data collection was assisted by a survey team. In the Geodetic GPS, a connection was established between the base and the controller via the internal radio in the device. Geodetic GPS data collection is expected to be conducted in open areas, with the base located in an area not obstructed by buildings or trees. Geodetic GPS data collection is performed by the controller in real-time while moving, whereas the base remains stationary at the predetermined coordinate point or benchmark (BM). Point collection is performed on raw coal piles with points spread across the piles. Point collection is not performed at the same points, but on the same piles.

Processing data to determine the results of measurements taken using both instruments. Data processing is carried out using software.

- The results of geodetic GPS measurements are exported directly to the controller and then transferred to a computer. The software calculates volume using top and bottom. Bottom refers to the existing database that has been collected previously. The top is the coal deposit area whose volume will be measured.
- A triangle is then created to generate DTM (Digital Terrain Model) data. The DTM results produce volume calculations for both instruments in the form of cut and fill. The coal volume is calculated in cubic meters (m^3), and then density calculations are performed to determine the coal tonnage [1].

$$T = v \times \rho \quad (1)$$

Description :
T = Tonnage (ton)
v = Volume (BCM)
ρ = Coal Density (kg/m3)

The final analysis was performed by calculating the percentage difference between the two instruments using deviation. The result of this formula is the percentage difference within the ASTM survey tolerance.

IV. RESULTS AND DISCUCCION

Geodetic GPS will be processed in the form of points containing coordinates. Then it will be processed to determine the volume of the measurement data. The following are the coordinate points of the device in the image. The measurement results in the image are from 2016 points measured by the Geodetic GPS device. In this study, contours were created based on topographic measurement results using a Geodetic GPS device. The following is a visualization of the contour with a 1-meter contour interval from the GPS Geodetic instrument in the image. Visualization of Digital Elevation Model (DEM) data is an important step in determining the differences in land surface topography after volume measurements have been taken. In this study, the DEM was created based on elevation point data from the measurements.

Fig 1. Point Cloud

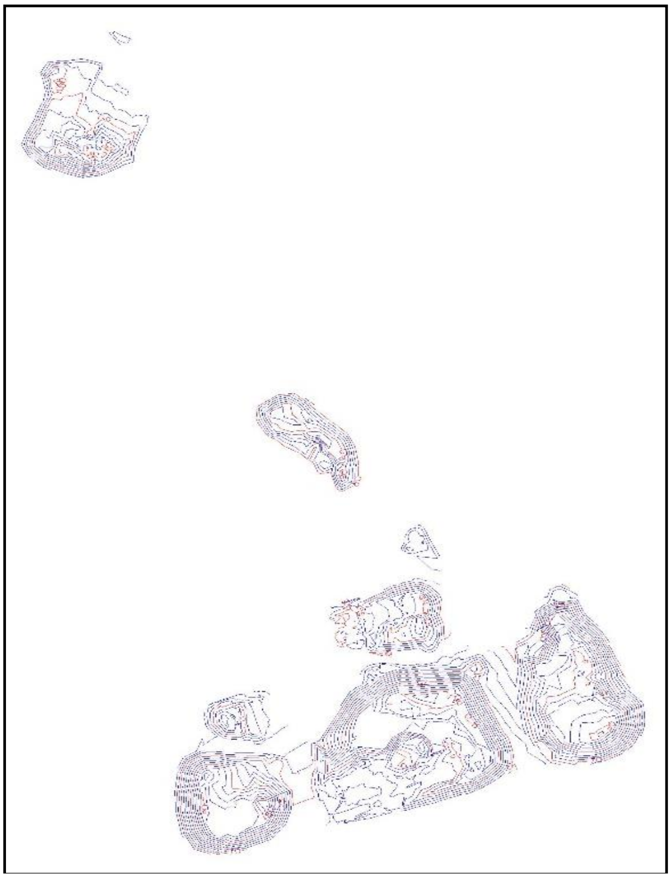

Fig 2. Contour

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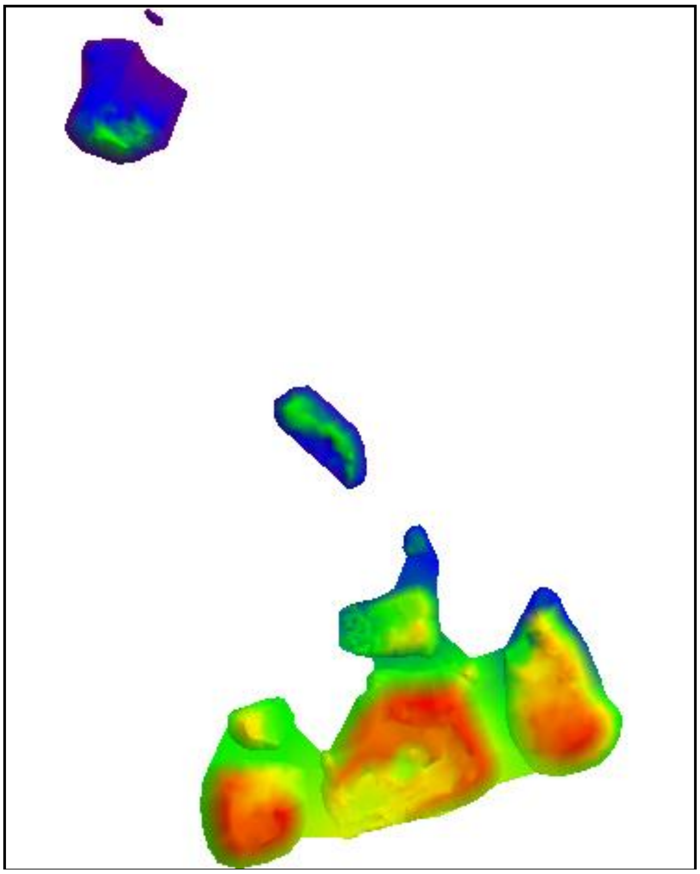

Fig 3. Visualization Digital Elevation Model

This calculation is based on the difference between the initial surface model before and after filling. The volume is calculated using a numerical approach based on the difference in height between the two surfaces, taking into account the distribution of elevation points. The results of the coal volume calculation using geodetic GPS with software using the cut and fill method produced the following calculations.

Table 1. Calculations Based on Geodetic GPS Devices

Block	GPS Geodetik (m^3)	Difference
C1	16.027,411	244,634
C2	10.660,596	342,559
C3	433,774	21,820
C4	8.073,047	166,119
C5	2.651,534	536,425
C6	54.523,822	342,695
C7	49.405,935	1.047,779
C8	29.139,027	210,522
total	170.915,146	1.110,944

After the calculation results are in cubic meters, they are converted to tonnage using the known density of coal, which is 0.96, to determine the difference from the coal weighing data using formula 1.

Table 2. Deviation

Weighting Data	Tonnage GPS Geodetik	Deviation
160,766.433	164,078.540	2%

Volume calculations were performed using the cut and fill method. The principle involves comparing two surface models—the initial surface and the final surface—to calculate the elevation difference (ΔZ) at each measurement point. Numerical calculations take into account the distribution of elevation points, resulting in more accurate outcomes. From the calculation results, the GPS Geodetic tonnage = 164,078.540 tons, weighing data = 160,766.433 tons, deviation = 2% (considered small, so the GPS Geodetic method is deemed accurate for estimating coal volume). A deviation of 2% indicates that the use of Geodetic GPS is sufficiently reliable compared to direct weighing methods. Factors influencing the deviation include: GPS device accuracy (dependent on signal quality and data processing methods). Coal density, which may vary due to moisture content or material mixtures. Time differences between GPS measurements and weighing, which may allow for changes in field conditions.

V. CONCLUSIONS

Geodetic GPS is effectively used for topographic measurements and calculating the volume of mining materials. Contouring and DEM creation facilitate visualization and analysis of land surface changes. The difference in results compared to direct weighing methods is relatively small (2% deviation), making it acceptable for volume estimation work. This method saves time and costs compared to manual measurements and can cover large areas with high precision. This is also evident from the ASTM tolerance of 2.78%, which remains below the measurement tolerance.

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