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The Comparison of Ritase and Survey Methods for Ore Volume Calculations

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SARI

Jumlah volume ore yang diekstraksi merupakan indikator penting kinerja tambang untuk membantu mengevaluasi pencapaian target produksi, perkiraan pendapatan dan biaya produksi secara akurat. Perhitungan volume ore yang diekstraksi umumnya dapat dilakukan dengan metode survey dan metode ritase (truck count). Masing-masing metode memiliki kelebihan dan kekurangan yang dapat mempengaruhi validitas data yang dihasilkan. Penelitian ini dilakukan di salah satu wilayah pertambangan nikel di daerah Konawe Utara untuk membandingkan jumlah volume nikel ore dari pengukuran survey dengan perhitungan volume dari jumlah ritase dan untuk mengetahui penyebab selisih nilai volume dari kedua metode tersebut. Penelitian ini menggunakan metode observasi lapangan dengan mengumpulkan data ritase dan pengukuran data survey di stockpile. Data survey di oleh menggunakan *software* surpac untuk mendapatkan volume material tergali dan data ritase diolah menggunakan formula tertentu. Hasil perhitungan menunjukkan rentang selisih volume yang cukup besar hingga mencapai 230 m^3. Ini terjadi karena pengisian bucket alat muat yang tidak memenuhi ketentuan, tekanan yang menyebabkan pemadatan tumpukan, dan proses *dumping* yang tidak tuntas.

Kata kunci: Volume Ore; Survey; Ritase; Pemadatan; *Dumping*.

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ABSTRACT

The amount of ore extracted is an important indicator of mine performance to help evaluate the achievement of production targets, estimates of revenue and production costs accurately. The calculation of the extracted ore volume can generally be performed using survey methods and the ritase method (truck count). Each method has advantages and disadvantages that can affect the validity of the data generated. The study was conducted in one of the nickel mining areas in the Northern Konawe region to compare the amount of nickel ore volumes from survey measurements to volume calculations of ritase volumes and to find out the causes of the difference in volume values of the two methods. The study used field observation methods by collecting Ritase data and measurement of survey data in a stockpile. The calculations

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show that the range of volumes is large enough to reach 230 m3. This is due to non-compliant load bucket filling, pressure-causing stack compression, and an improper dumping process.

Keywords: *Ore Volume; Survey; Ritase; Compression; Dumping*

INTRODUCTION

In mining operations as well as in various other activities, the management, handling and stacking of material is a fundamental phase and process, making the monitoring of these phases critically important (Tucci, et al., 2019). The accumulation of materials or ore in open-pit is generally conducted within stockpiles and at the mining front. Calculating the volume of ore accurately in the stockpile during the exploitation phase is crucial for effective material management, determining economic value, tracking mining progress, and planning production relative to the mine's operational timeline.

In practice, measurements of ore volume are generally obtained through survey methods, which are subsequently processed using certain software. Apart from this method, the volume of excavated ore can be estimated by calculating transportation speed (Ilham, 2021). When determining the volume of production or ore, discrepancies often arise between production results recorded in rarity logs and those obtained from survey methods based on mine progress data. Consequently, it is necessary to compare these calculation methods to evaluate their accuracy and efficiency, as well as to identify factors contributing to the observed differences in volume.

Survey Method

Mining surveys include a range of activities aimed at collecting geometric data about earth's surface, particularly focusing in the geometry of the mined area. (Coronas and Lesang, 2022; Hasvah, 2021). These surveys are crucial during the planning phase of mining activities, as they provide essential information regarding the location to be mined, including topography and geological features on the site. The data obtained from these survey activities are subsequently processed to form the basis for mine design and determining the optimal mining location.

During exploitation activities, surveys are also required to check the mine progress or to calculate the total ore volume that has been mined or OB that has been moved as well as remaining reserves of minerals that have not been excavated (Imanuel and Ryanto, 2020). Advanced tools such as theodolites, total stations, GPS, TLS (Terrestrial Laser Scanning), and GNSS (Global Navigation Satellite System) technology are employed to facilitate accurate measurements and calculations. For instance, theodolites and total stations are used for precise angle measurements, while GPS and GNSS technologies provide accurate positioning data. TLS technology, on the other hand, offers high-resolution 3D scanning capabilities, enabling detailed modeling of the site's surface (Alsayed and Nabawy, 2023; Mantey and Aduah, 2021).

Survey methods are also conducted during the exploitation stage to assess the mine's progress. These surveys help determine the total volume of minerals extracted, the amount of overburden (OB) moved, and the remaining mineral reserves that have not been excavated. Real-time monitoring using advanced surveying techniques allows for continuous assessment of the mine's performance, enabling adjustments to be made to optimize extraction processes.

This method, the creation of a digital terrain model (DTM) involves using detailed points from x, y, and z coordinate positions. This DTM is a crucial tool for calculating the volume of mined material by comparing the original ground surface with the planned ground

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surface. Software such as Surpac can be utilized for these calculations, providing precise estimates of the excavated volume (Coronas and Lesang, 2022; Hasvah, 2021).

Ritase Calculation (truck count)

Truck count is the amount of production recorded in the mining area by the production recording team (checker). This record covers the daily dump truck loading routine, including every load transported (Ilham, 2021). The resulting data was then processed using the Microsoft Excel program.

In calculating the excavation volume and production amount, the capacity of the transport container and the number of rotation cycles play significant roles. The capacity of the transport equipment container is directly proportional to the volume of excavation being transported, the number of cycles and the overall production volume of the work equipment (Diputra, 2015). The number of cycles can be calculated using the equation (Hardianti, et al., 2023):

$$TC = Ret \times V\_vessel \quad (1)$$

$$V\_(vessel) = V\_bucket \times x \quad (2)$$

Where TC is the truck count (bcm), Ret is the rate or Ritase, while V vessel is the standard volume of the conveyance body, V bucket is the standard bucket volume of the loading equipment, and x is the amount of material (in buckets) for one conveyance body.

RESEARCH METHODS

The research was conducted at a nickel mining company in North Konawe Regency. (Figure 1).

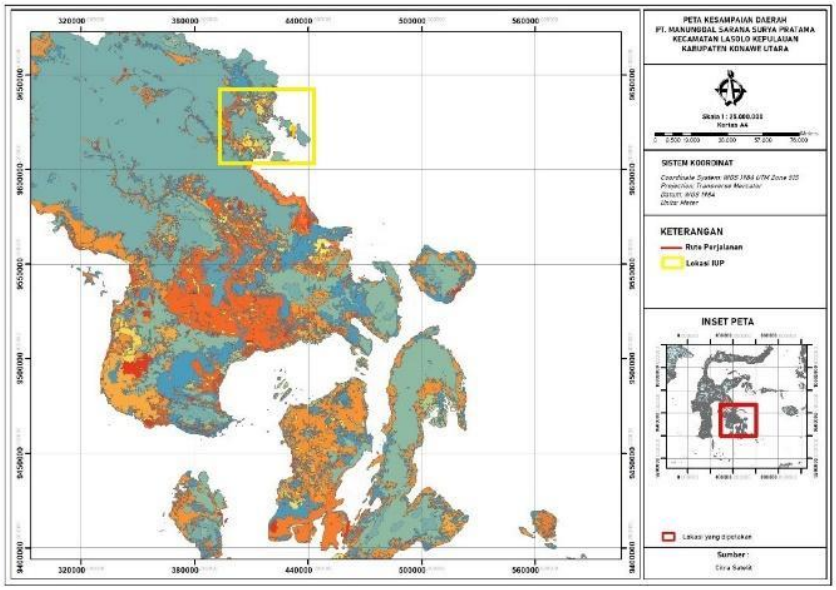

Figure 1. Research location

This research was conducted using qualitative methods, with data collected directly in the field. The measurements were conducted using the survey method with total station, a

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precision measuring instrument (angle and distance) which is integrated with additional equipment in the form of a stand or tripod as a tool holder, a prism in the form of a tool to obtain x, y, z coordinate point values. This setup facilitated the accurate collection of spatial data, which is essential for detailed spatial analysis and mapping in the field. Survey data was processed using Surpac software to obtain the volume of material excavated. Volume calculation calculated using the truncated pyramid formula (Sepriadi, et al., 2023; Suwaji, 2008):

$$V = 1/3\ t\ (L1\sqrt{(L1.L2)}+L2) \quad (3)$$

Where V is the dome volume, t is the dome height, L1 is the base area and L2 is the roof area. For Ritase data *dump truck was* obtained from the checker who is the officer responsible for recording the transportation of nickel ore to *stockpile* or the volume of exposed nickel.

RESULT

Calculations Using Survey Data

Estimation of the ore volume in the EFO 5 stockpile was carried out on 15 piles using a total station with a prism as a reference point and a measurement spacing of 1 meter. By using Surpac 6.6.2 software and equation (3), the respective dome volumes are obtained in table 1.

Table 1. Obtained ore volume in the EFO 5 stockpile using survey method calculations

Dome	Volume (m^3)	Dome	Volume (m^3)
1	280,90	9	545,48
2	575,69	10	458,34
3	293	11	414,99
4	457,22	12	228,89
5	253,12	13	380,60
6	244,79	14	389,76
7	231,07	15	374,23
8	360,32		

Calculations Using Ritase (Truck Count) Data

The truck count is the number of cycles of the Hino 500 dump truck operating to transport ore material to the stockpile, where the transport equipment has a body capacity of ± 1.2 m3, while the loading equipment used is a PC210 excavator.

In a single transport cycle, a truck can load 9 buckets. The EFO 5 stockpile comprises 15 piles, each exhibiting a different loading rate. A truck's maximum volume per cycle can reach 16.2 tons, which is then multiplied by one stack. The calculated drainage volumes for the 15 piles, derived from equations 1 and 2, are presented in Table 2.

Table 2. Calculation results of ore volume based on the number of cycles/ritase.

Dome	Number of Ritase	Volume (m^3)

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1	30	324
2	61	658,8
3	36	388,8
4	60	648
5	30	324
6	30	324
7	30	324
8	40	432
9	60	648
10	60	648
11	60	648
12	32	345,6
13	40	432
14	46	496,8
15	40	432

Based on volume calculation results (tables 1 and 2), both methods indicate a significant difference in quantity. The volume comparison can be seen more clearly in Figure 2.

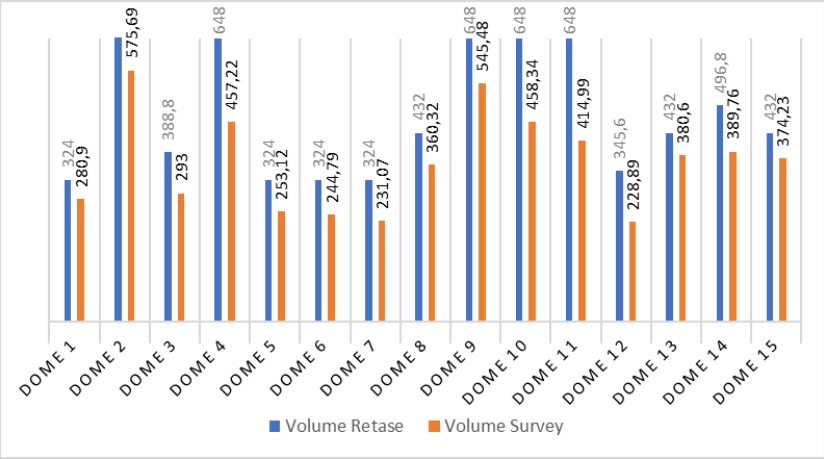

Figure 2. Comparison graph of the volume of each dome.

Based on the field observations, the significant difference in volume gain from the two methods is attributed to several factors:

1. Non-compliance with excavator bucket capacity during loading. The excavator bucket does not consistently meet the company's specified capacity of 18 tons when loading material onto the truck.
2. Moist and adhesive ore material. Certain ore transported to the stockpile remains high in moisture and sticky, causing difficulties in complete dumping. Consequently, residual ore adheres to the dump truck.
3. Compaction. During the trimming ore process, the excavator occupies the dome, causing pressure and compaction of the pile. This compaction results in a smaller survey value, contributing to the observed volume discrepancy.

CONCLUSION

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There is a fairly large range of differences between ore volume calculations between the survey method and the ritase method, ranging from 43.1 m3 to over 230 m3. Several factors contribute to these variations, including the treatment of ore during the loading and stacking process. To enhance the accuracy and effectiveness of volume calculations using these two methods, it is essential to ensure consistent filling of the excavator bucket, avoid compaction of the ore pile due to excessive pressure, and facilitate complete unloading during the dumping process.

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