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Geospatial-based Mining Geometry Analysis to Improve Operational Efficiency of PT AMM Jobsite Mifa Bersaudara (2024)

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ABSTRACT
Coal mining activities require the establishment of good and correct mine geometry to support effective and safe operations. However, many companies face challenges in ensuring that the geometry formed conforms to set standards. This research highlights the limited use of UAV technology in mine geometry optimization. This research aims to analyze geometry shaping at mine sites using geospatial data and raise awareness of the importance of good geometry in mining. The methods used include a combination of geographic information systems (GIS) and aerial surveys with UAVs. The mine geometry information was presented in map form to improve understanding of the geometry formation at each mine site. The results showed a 14% increase in geometry achievement, from 67% to 81%, after the application of the geospatial-based mine geometry information map. This reflects a significant increase in the formation of geometry in accordance with applicable rules. This finding shows the great potential of utilizing geospatial methods in the mining industry to improve the achievement of good geometry. In addition, this research can improve mine safety, the effectiveness of mine site inspections, and more organized repair planning, thus providing practical benefits to PT AMM's operations.

Keywords: Geospatial, Geometry, Good and correct mining rules, Coal Mining

INTRODUCTION
Mining activities in coal mines are highly dependent on the establishment of good and correct mine geometry (Ullah et al., 2018; Zhang et al., 2017). Optimal mine geometry not only supports effective and efficient operations, but also contributes to occupational safety. However, many mining companies face the challenge of ensuring that their geometry conforms to established standards (Firoozi et al., 2024; Hancock, 2019; Van Wyk, 2015; Wagner, 2019). Although there have been several previous studies addressing geometry monitoring techniques, the use of UAV (Unmanned Aerial Vehicle) technology in the context of mine geometry optimization is still limited.

The problem faced in this research is the lack of understanding and utilization of geospatial technology, especially UAVs, to improve the formation of mine geometry in accordance with good mining principles. This research aims to close the gap by integrating UAV methods in mine geometry analysis, which is expected to increase awareness of the importance of good geometry among all stakeholders (Adero, 2023; Dang & Nguyen, 2023; Giordan et al., 2020; Saputra et al., 2023; Shahmoradi et al., 2020). At the PT MIFA Bersaudara mine site located in West Aceh Regency, whose current mining contractor is PT Antareja Mahada Makmur, there are agreed standards in the formation of mine geometry, such as a maximum road slope of 10%, a slope on the low wall of 30 degrees, a slope on the high wall of 43 degrees. To fulfill the achievement of a well-formed and correct mine geometry, monitoring and inspection of mining activities in geometry formation is required.

With the advancement of technology, monitoring and inspection of mine geometry formation can be done more effectively. The use of geospatial information in supporting mine geometry inspection and monitoring activities can improve the accuracy of the formed mine geometry. Information in a broad sense, including Geospatial Information (GI), is a tool for policy-making, decision-making, and implementation of activities related to earth space. The utilization of remote sensing technology combined with geospatial analysis is an integrated methodology in monitoring geometry at mine sites, which is able to convert quantitative image values into data that can be read visually and contains qualitative values (Bürck, 2020; Lillesand et al., 2015; Samaei et al., 2024; Sikakwe, 2023).

PT Antareja Mahada Makmur is a coal mining contractor company operating at Jobsite Mifa Bersaudara, Sumber Batu village, Meurbeo sub-district, West Aceh district, requires Geospatial information to analyze the geometry of the mine formed to improve the achievement of geometry in accordance with good and correct mining rules in accordance with Permen ESDM Number 26 of 2018. The urgency and practical significance of this research is clear. With increasing pressure to comply with strict mining regulations and improve operational efficiency, this research offers innovative solutions through the utilization of geospatial technology. The results of this research are expected to not only provide theoretical contributions, but also provide practical benefits to the mining industry, including improved safety, efficiency and regulatory compliance.

RESEARCH METHODS

1. Use of a UAV (Unmanned Aerial Vehicle) to perform data acquisition.

The use of unmanned aerial vehicles (UAVs) in topographic data acquisition has become increasingly popular in recent years. One of the main reasons is the relatively low operational cost compared to conventional methods such as aerial photography using manned aircraft (Giordan et al., 2020; Shakhatreh et al., 2019). Photogrammetric methods using UAVs, often referred to as low-cost photogrammetry, allow mining companies to acquire accurate spatial data at a more affordable cost. This is especially beneficial for companies operating in remote areas or with difficult-to-access terrain, as the cost of mobilizing equipment and manpower can be very high. The selection of data acquisition using UAVs is due to the low-cost photogrammetry method and the use of unmanned aerial vehicles (UAVs). The advantage of this UAV method is that it can be used on topography with difficult accessibility.

2. GNSS used to perform PPK (Post Processing Kinematic)

Post-Processed Kinematic (PPK) is a measurement technique that combines data from two main sources, namely the Global Navigation Satellite System (GNSS) and an unmanned aerial vehicle (UAV). GNSS data collected from reference stations and UAVs are used to calculate the position of objects very accurately. The process involves collecting raw GNSS data from both sources, and then processing these data together using specialized software. By combining data from these two sources, positioning accuracy can be significantly improved compared to using only one data source. The PPK method is a method used to obtain the position value of an object using GNSS data that is collected first and then in the process combined with the results from the UAV.

3. Aerial photo modeling

The processing of aerial photography data obtained from UAVs produces various derivative products that are very useful in various applications, especially in mining. After passing through pre-processing stages such as camera calibration and data quality control, the aerial photographs are then mosaicked to form a 3D model of the earth's surface. This 3D model is then further processed using photogrammetric techniques to produce point cloud data, Digital Elevation Models (DEMs), and orthophotos.Geometry analysis using Geographic Information Systems (GIS)

The implementation of GIS in geometry analysis can analyze slope, slope, length, width, and height. Geographic Information Systems (GIS) has become a very useful tool in mining geometry analysis. With the ability of GIS to process complex spatial data, we can perform various types of analysis on mine geometry. One of the advantages of GIS is its ability to calculate geometry parameters such as slope, slope, length, width and height. This analysis is essential for evaluating slope stability, planning the layout of mine facilities, and optimizing the mining process.

4. Map Creation

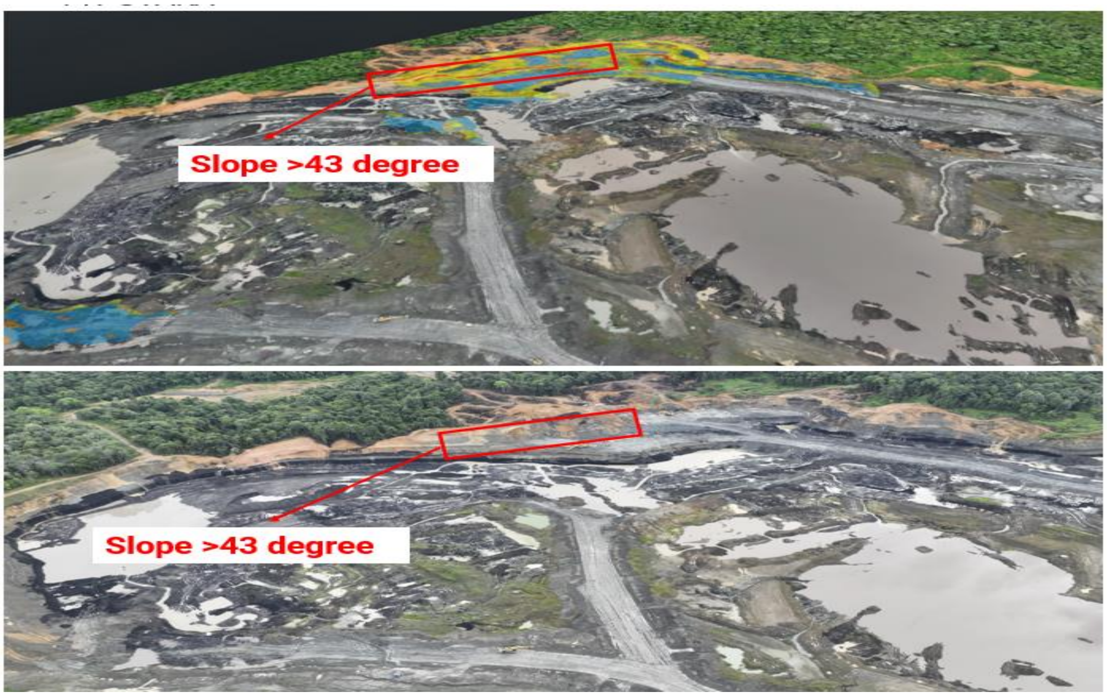
The mining geometry map generated from the photogrammetric process using UAVs not only presents a three-dimensional visualization of the mine area, but also provides more detailed information on the suitability of the geometry. By analyzing the data obtained from the UAV, experts can compare the actual geometry in the field with the planned geometry design. This makes it possible to identify any deviations or discrepancies, such as slopes that are too steep, inappropriate bench widths, or pit heights that exceed permitted limits.

An effective innovation process involves a systematic series of steps. It starts with identifying the problem that is the focus of attention. Once the problem is identified, the next step is to analyze the impact that the problem has, both directly and indirectly. By understanding the impact, we can set clear and realistic goals for improvement. Next, a root cause analysis is conducted to identify the main factors that cause the problem. Once the root cause of the problem is identified, an appropriate and effective solution can be determined.

Once a solution has been determined, the next step is to develop a detailed improvement plan. This plan includes the steps to be taken, the resources required, as well as the implementation schedule. Once the plan is developed, the necessary resources such as labor, budget, and equipment must be prepared. The implementation stage is where the improvement plan is put into action. During implementation, data needs to be collected regularly to monitor progress and measure performance. The final stage of the innovation process is the evaluation and analysis of achievements against set goals. This evaluation aims to measure the success of the solutions that have been implemented and identify areas that still need improvement.

RESULTS AND DISCUSSION

The results of the innovation show that the presentation of geospatial-based geometry information can increase the knowledge of each map reader so that it affects the improvement of the achievement of the formation of mining geometry formed in accordance with good and correct mining rules.

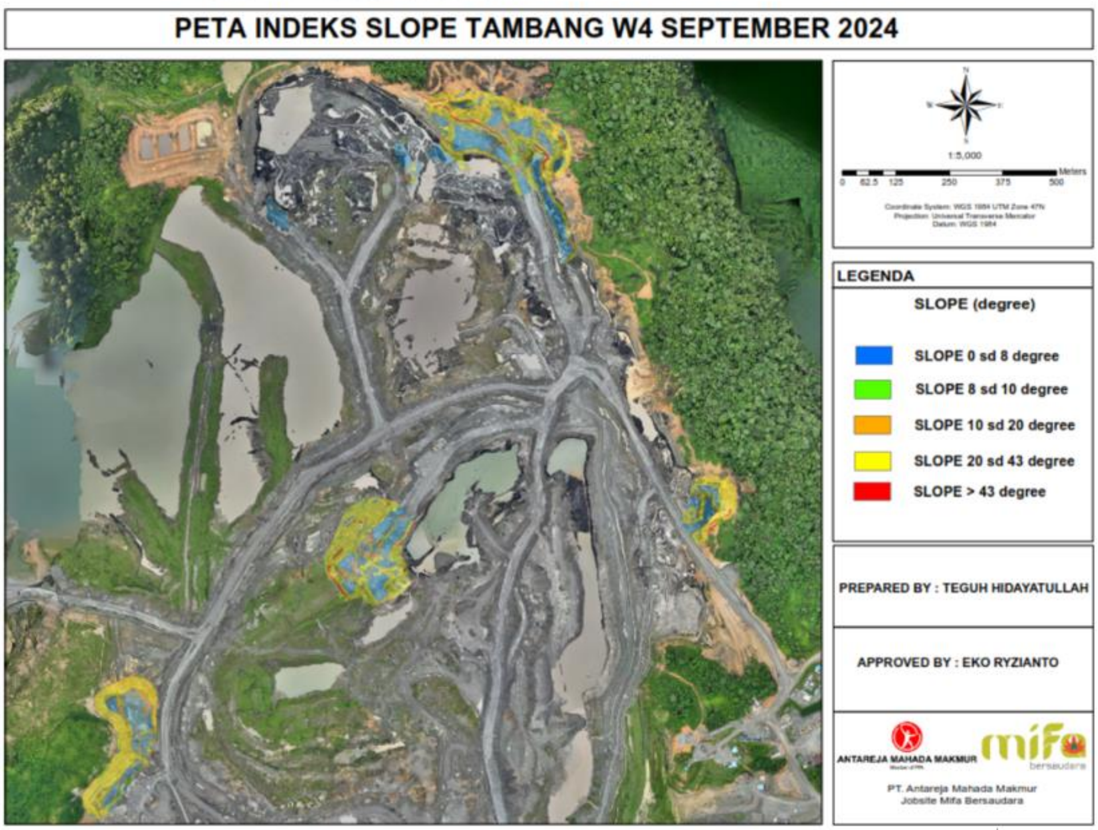


The use of geospatial technology in the presentation of mining geometry information has opened up new opportunities to improve the understanding and knowledge of all stakeholders. With better and interactive data visualization, information about mine geometry can be presented in a clearer and easier to understand manner. This allows engineers, managers, and decision-makers to get a more comprehensive picture of the mine geometry conditions in real-time. As a result, decision-making processes related to planning and controlling mine operations can be carried out more quickly, accurately and effectively.

Improved knowledge and understanding of mine geometry thanks to geospatial technology has a positive impact on the quality of the final output. With better data visualization, engineers and field operators can more easily identify potential problems or deviations from the initial design. This allows corrective action to be taken immediately, so that the mine geometry can always be in accordance with good mining practices. In addition, geospatial data visualization can also be used to identify areas of potential danger, such as landslides or flooding, so that preventive action can be taken early.

Here is a visualization of geospatial-based geometry information, Mine geometry is a crucial element in mining activities. Proper design and implementation of mine geometry will greatly affect the efficiency, productivity and safety of mining operations. However, a deep understanding of mine geometry is often limited to technical circles. The presentation of mine geometry information in the form of geospatial maps can be an effective solution to overcome this obstacle. Geospatial maps are able to present complex information about mine geometry visually, making it easier to understand by various parties, from top management to field workers.

With detailed and interactive geospatial maps, individuals involved in mining activities can gain a better understanding of the mine geometry. This will increase their awareness of the importance of good mine geometry in supporting the continuity of mining operations. In addition, geospatial maps can also be used as an effective communication tool to convey information related to mine geometry to various stakeholders, such as the government, surrounding communities and investors.



The research conducted aims to examine the effectiveness of using geospatial maps in improving understanding and awareness of mine geometry. The results showed a significant increase in mine geometry attainment after the implementation of geospatial maps. The percentage of geometry attainment increased from 67% to 81%, representing an increase of 14%. This indicates that the visualization of mine geometry data in the form of geospatial maps is very effective in increasing awareness and understanding of the importance of good mine geometry.

The results of this study have very important implications for the mining industry. The use of geospatial maps in the management of mine geometry can improve the efficiency of operations, reduce the risk of work accidents, and improve compliance with laws and regulations. Therefore, it is recommended that mining companies integrate geospatial maps into their information management systems. In addition, it is necessary to conduct training for all employees so that they can make maximum use of geospatial maps. Thus, geospatial maps can be an invaluable tool in supporting the sustainability of mining activities.

This research has successfully revealed the great potential of utilizing geospatial technology in improving the quality of mining geometry management at PT AMM. The presentation of mining geometry information in the form of interactive digital maps has proven to be able to increase the awareness and concern of all parties involved in the importance of maintaining the suitability of mining geometry with good and correct mining rules. Clear and easy-to-understand geospatial data visualization allows technicians, supervisors and management to more easily identify potential problems with mine geometry and take timely corrective action.

In addition to raising awareness, the use of geospatial maps also contributes to the improvement of work safety aspects in mining. With accurate and up-to-date digital maps, the risk of work accidents due to unsafe mine geometry conditions can be minimized. Geospatial maps can be used to identify potentially hazardous areas, such as unstable slopes or narrow mine roads, so that preventive measures can be taken before an accident occurs. In addition, geospatial maps can also be used to plan safe evacuation routes in the event of an emergency.

The implications of this research are significant for the mining industry. The results show that investment in geospatial technology is a strategic move that can provide long-term benefits for mining companies. By utilizing geospatial maps, companies can improve operational efficiency, reduce production costs, and enhance their reputation as a company that conducts responsible mining activities. In addition, the use of geospatial maps can also support the government's efforts to supervise and control mining activities in accordance with applicable laws and regulations.

CONCLUSION

Geospatial presentation of mine geometry information maps provides significant benefits in improving the quality of mining operations. With clear and accurate data visualization, employees can easily understand the overall geometry of the mine. This enables them to make better decisions in the execution of daily tasks, such as drill siting, material transportation and mine infrastructure maintenance. In addition, geospatial maps can also be used to identify potential hazards and risks associated with the mine geometry, so that preventive measures can be taken earlier.

The implementation of geospatial-based geometry information maps is highly recommended to be implemented in all mining sites. By utilizing geospatial information technology, mining companies can create a safer and more efficient working environment. In addition, accurate and up-to-date geospatial data can be used to support long-term planning, such as the development of medium and long-term mine plans. Thus, mining companies can ensure that their operational activities are always in accordance with good and correct mining principles, and minimize a negative impact on the environment.

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