**Real-Time Detection of Perimeter Breaches Using High-Precision GPS for Enhanced Safety in High-Risk Dumping Zones in Open Pit Mining**

M R Pratama1, S Widodo2 and K P Adiprima3

1. Operation Research Engineer, PT. Pamapersada Nusantara, Jakarta Indonesia 13930. mochamadrp@pamapersada.com:

2. Software Engineering Manager, PT LAPI ITB, Bandung Indonesia 40132. sugengwidodo@lapi-itb.com:

3. HSE System & Compliance PT. Pamapersada Nusantara, Jakarta Indonesia 13930. khrisna.protecta@pamapersada.com:

Keywords: Mining Operations Safety, Virtual Safety Perimeters, High-Precision GPS, High-Risk Dumping Zone

# ABSTRACT

Mining operations are high-risk activities, particularly in material dumping in high-risk disposal areas. A high-risk disposal area has one or more of these conditions: a disposal bench height of more than 5 meters and its base filled with water or mud. The critical concern in a high-risk disposal area is slope stability, which is influenced by the material properties, bench heights, and water levels. Organizations must set a safety distance limit for trucks dumping materials in safe dumping zones to manage the safety risks in high-risk dumping zones based on a geotechnical assessment. If trucks exceed the designated safe limit in dumping zones, they could sink or slide into water-filled zones, posing a severe safety risk. The authors researched a Real-Time Detection System using a High-Precision GPS (Global Positioning System) installed in Komatsu HD785-7 trucks to monitor these safety limit boundaries. Virtual safety limits are established with GPS devices positioned by a Komatsu DZ 375 Bulldozer, which marks the safe limit dumping zones. Linear equations are applied between GPS points to determine and create marked limit boundaries accurately. Truck operators are guided to maintain a safe dumping distance based on the truck's position relative to these limit boundaries. Additionally, any boundary violations are recorded by CCTV (Closed-Circuit Television) cameras on mobile towers, providing crucial visual evidence for incident analysis and safety improvement. The system is implemented in high-risk dumping zones, generating real-time alerts to operators in the truck's cabin and sending notifications to the supervisors. A central dashboard allows supervisors to monitor dumping activities and boundary breaches. This real-time monitoring facilitates prompt responses to potential hazards and ensures adherence to safety standards. In conclusion, the High-Precision GPS-based Real-Time Detection System has proven effective in enhancing safety in high-risk dumping zones by preventing unauthorized dumping and ensuring regulatory compliance. This approach holds significant potential to improve safety standards in open-pit mining, ultimately reducing accidents and creating a safe work area for operators and supervisors in high-risk Disposal areas.