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Optimization of Dewatering Management Using Smart IoT Control – Multiflow On/Off Monitoring System (SIC-MUFS) at PT. PPA Jobsite SKS, October 2024 – March 2025

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KEYWORDS
Climate change; dewatering management; sump; working near water; digitalization

ABSTRACT
Global climate change critically threatens operational sustainability in mining. At PT PPA Jobsite SKS, it was the highest operational risk, causing unpredictable heavy rainfall that disrupted dewatering management. Workers frequently operated pumps near water—a high-risk activity—increasing accident potential. This study aimed to optimize dewatering by implementing digital technology to reduce near-water work risks and boost productivity. Using risk analysis and root cause assessment, the Smart IoT Control – MultiFlow On/Off Monitoring System (SIC-MUFS) was developed and deployed from October 2024 to March 2025. SIC-MUFS enables remote pump operation, real-time water level monitoring, and automated alerts to the Central Control Room. Results show critical near-water work decreased from 2–3 times/day to once daily. The system also prevented haul road flooding, improved Pit Service team safety and productivity, and supported faster, data-driven decisions. In conclusion, SIC-MUFS effectively enhances dewatering management, mitigates accident risks, and increases operational efficiency. IoT-based adoption is recommended as a sustainable approach to building climate-resilient and safer mining operations.

INTRODUCTION

Based on the Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia No. 26 of 2018 concerning the Implementation of Good Mining Rules and Supervision of Mineral and Coal Mining, all mining companies are obliged to implement Good Mining Practices (GMP) (Agung Hardiyanto et al., 2023; Kemalasari et al., 2023; Nasrudin Usman et al., 2022; Pratama, 2022; Sudaryat, 2025). GMP itself is a principle for carrying out mining activities in accordance with applicable rules, through well-planned efforts that apply appropriate technology based on effectiveness and efficiency, conserve mineral resources, control and maintain environmental functions to ensure work safety, accommodate community wishes and participation, produce added value, improve the capabilities and welfare of surrounding communities, and create sustainable development (Hidayat et al., 2023; Thamrin et al., 2023; Toba et al., 2025). One effort by the management of PT. PPA Jobsite SKS in implementing GMP rules is to manage the aspects of Mining Operational Safety contained in one of the SHE Department's business processes (Ariffin et al., 2022).

In the first semester of 2024, an accident occurred at one of the mining companies that resulted in a fatality. The accident happened during critical work near water. The Chief Inspector of Mines (KaIT) issued a circular letter on this matter, urging all mining personnel to prioritize preventive efforts to avoid accidents during critical work, especially near water.

The frequency of critical work at PT. PPA Jobsite SKS during 2024 was quite high, averaging 2–3 times per day. This aligns with Enterprise Project Risks data, which identifies climate change as the highest risk. Weather conditions at PT. PPA Jobsite SKS are unpredictable, resulting in actual working hours that far exceed planned hours. Consequently, the frequency of critical work near water (pump operations in the sump area) has increased.

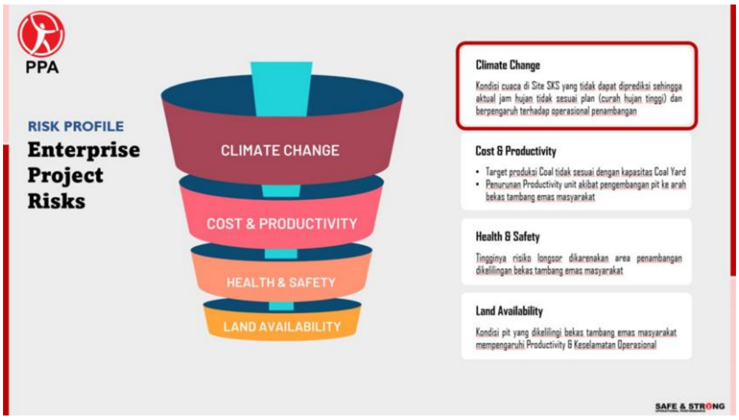


Figure 1. Enterprise Project Risk PT. PPA Site SKS in 2024

Source: PT. PPA Jobsite SKS Risk Management Data, 2024

Problem Stratification

Source : PT. PPA Jobsite SKS Period

: January – September 2024

Data Collection : Muzayyinul Fikri

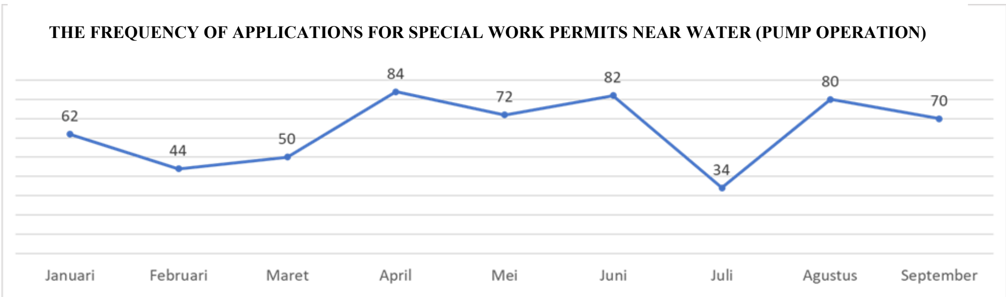


Figure 2. Graph of the Frequency of Applications for Special Work Permits Near Water (Pump Operation)

Source: Data Dispatch Analyst PT. PPA Jobsite SKS, Processed by Mirza Baidawi S.

Source : Data Dispatch Analyst PT. PPA Jobsite SKS

Periode : January – September 2024

Data Collection : Mirza Baidawi S.

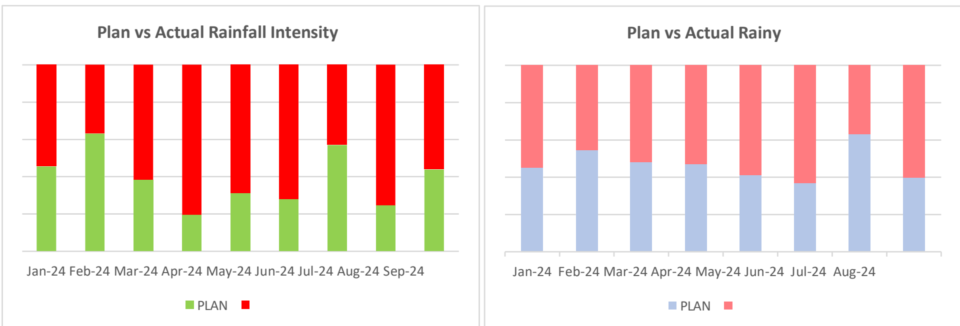


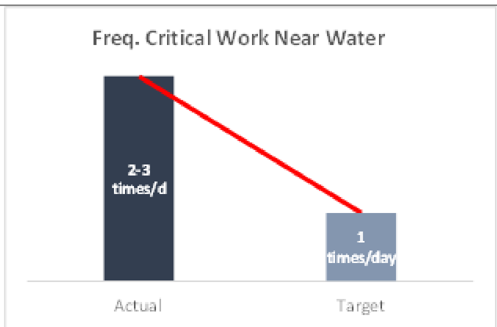
Figure 3. Rainfall Intensity Data Histogram & Rain Hours

Source: PT. PPA Jobsite SKS Meteorological Data, 2024

After identifying the issues that need improvement, the team decided on the theme "Optimizing Dewatering Management at PT. PPA Jobsite SKS." This theme aims to achieve several goals, including: reducing the risk of mine accidents related to near-water work by providing adequate supporting technology infrastructure; easing the workload of the Pit Service team, particularly in managing dewatering during extreme weather conditions; and ensuring more efficient dewatering management to prevent disruptions in vehicle mobility and mining operations, which ultimately helps maintain productivity.

Defining Target Targets

Frequency of Critical Work Near Water	
Actual	**1**
Objectives	**0**



The team set a target in the form of reducing the frequency of critical work nearby (pump operation in sump) from 2-3 times/day to 1 time/day for 6 months. Because the level of risk in critical work must be lowered, one of which is by reducing the frequency of activities near water.

The goal is to optimize the performance of Dewatering Management to reduce the risk of accidents and enhance operational productivity. This can be measured by lowering the frequency of critical work near water during the dewatering process by 50%, reducing it from 2-3 times per day to just once a day. Achieving this is possible by implementing adequate control measures, particularly through the use of technology. IoT technology, in particular, can be leveraged to improve the performance of Dewatering Management, especially in terms of safety and productivity. The project is scheduled to be carried out from October 2024 to March 2025.

This project focuses on addressing the high risk of accidents, including LTIs and fatalities, that arise from working near water in the Dewatering Management process, which significantly impacts operational productivity (Hadj Mansour et al., 2023; Qi et al., 2024; Tan et al., 2024). The primary challenge at the SKS Jobsite is the high intensity of rainfall, which affects the continuity of mining operations. To tackle this, the team proposes an innovative solution utilizing the Smart IoT Control – MultiFlow On/Off Monitoring System (SIC-MUFS) (Abba & Light, 2020; Aminu et al., 2023; Halim et al., 2023). This system aims to reduce the risk of mine accidents in dewatering work and decrease the workload of the Pit Service team, preventing potential losses from decreased productivity. The project, titled "Optimization of Dewatering Management using Smart IoT Control – MultiFlow On/Off Monitoring System (SIC-MUFS) at PT. PPA Site SKS," will be executed from October 2024 to March 2025. The focus of the improvement, as outlined in the SIPOC diagram, is to optimize Dewatering Management at the PT. PPA Site SKS. The project's customer is the SHE & Operation department of PT. PPA Jobsite SKS.

This research aims to optimize dewatering management to reduce the risk of work accidents in near-water areas and increase operational productivity. The expected benefits of this research are the creation of a remote pump monitoring and control system that can minimize direct interaction of workers with hazardous areas, improve the efficiency of mine water handling, and support the application of digital technology in safer and more sustainable mining operations.

METHOD

The improvement steps for the 2024-2025 period consist of several stages. First, the theme determination stage will be carried out during the planned period, followed by identification of the factors causing the problem. The next step is to determine solutions and plan improvements. The improvements will then be implemented according to the plan, and the results will be evaluated. Next, the standardization stage will be carried out to ensure consistency and quality in the improvement process. Each step will be carried out according to the established plan, and its implementation will be recorded based on a comparison between the plan and reality for each specified period.

Facilitator	
Comments	Daily : 14 October 2024
The issue ***of climate change*** at the SKS jobsite has a great impact on the sustainability of the project, both from operational and safety aspects. PPA must *survive* in facing this climate challenge, one of which is through the improvement efforts carried out. It is hoped that this innovation can support the performance of the jobsite so that operations run safely, productively and efficiently.	 Ari Widiyandono

In the 1st semester of 2024, the frequency of critical work near water, especially in pump operations in the sump, is very high. This was influenced by very high rainfall exceeding the plan.

Figure 4. Causal Flow of Work Frequency Near High Water

Source: Analysis by the research team based on operational data, 2024

The team had to further investigate the causes of the high frequency of critical work near water, so that the risk of mining accidents in these activities could be lowered and the company did not suffer losses due to decreased productivity.

As a result of the identification and analysis carried out by the Team, there are several things that are the cause of the high frequency of critical work near water at PT. PPA Jobsite

SKS, as follows:

Table 1. Causal Stratification

Category	Direct Causes
Method	Dewatering work (pump operation) is carried out by crossing the sump every beginning & end of shift
Machine	Not yet Available Equipment/Technology Supporters As Remote Pump Monitoring
Environment	The elevation of the water *sump* increased drastically beyond the plan

Source: Analysis by the research team, 2024

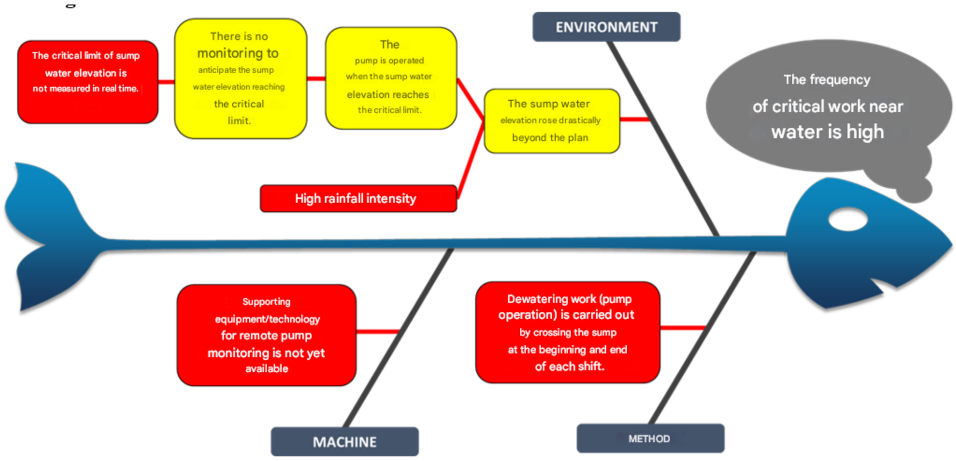


Figure 5. Diagram Fishbone

Source: Root cause analysis conducted by the research team, 2024

Based on the results of the root of the problem analysis using the fishbone diagram above. Some possible root causes of the problem were found as follows:

Table 2. The Root of the Problem

No	The Root of the Problem	Status	Priorities
1	Dewatering work is done by crossing the Sump each shift	Controllable	**1**
2	There is no supporting equipment/technology available for remote pump monitoring	Controllable	**2**
3	The critical limit of the elevation of the water *sump* is not measured in real time	Controllable	**3**
4	**High rainfall intensity**	**Uncontrollable**	**-**

Source: Analysis by the research team, 2024

Table 3. Alternative Solutions

No	Root Cause	Rank	Improvement Idea	
			Alternatif 1	**Alternatif 2**
1	Jobs Dewatering (pump operation) is carried out by crossing the Sump every shift	1	Digitization of pumps for remote operation	-
2	Not yet Supporting equipment/technology available To monitor the pump. remote	2	Implementation of an IoT-based monitoring system for *real-time monitoring* of pump conditions	Installation of *digital dashboards or* mobile applications *for* real-time *monitoring*
3	The critical limit of the elevation of the water *sump* is not measured in *real time*	3	Increased frequency of water sump elevation measurement (2	Installation Water elevation sensor *Sump* that gives a warning

times/shift)	early automatically

Source: Brainstorming session and analysis by the research team, 2024

Based on the solution analysis using the Grand Slam solution matrix method, weighing the estimated cost and benefit, the following results were found:

Table 4. Analysis of Alternative Solutions

No	Solution Name	Cost Estimation	Increase in Work Performance	Rank
1	Digitization of pumps for remote operation	IDR 3,000,000	The frequency of critical work may decrease because Pit Service does not need to cross the sump at all times to operate Pump	1
2	Implementation IoT-based monitoring system for monitoring real time Pump Condition	IDR 5,000,000	Pump monitoring can be done remotely so that Lowers the frequency of critical work Near the water	2
3	Digital dashboard creation or mobile apps for real-time monitoring	IDR 10,000,000	Data Results monitoring Pump direct appeared, so that Simplify Process Analysis & decision-making	3
4	Installation of a water sump elevation sensor that provides automatic early warning	IDR 2,000,000	Increase visibility of the operational team and accelerate Response to elevation changes Water Sump	4
5	Increased frequency of water sump elevation measurement (2 times/shift)	IDR 1,000,000 /month	The elevation of the water sump is more updated so that it becomes a reference for the operational team to Operation Pump	5

Source: Cost-benefit analysis using the Grand Slam matrix, 2024

Based on the analysis using the Grand Slam matrix, the team decided to implement 4 (four) alternative solutions selected.

RESULT AND DISCUSSION

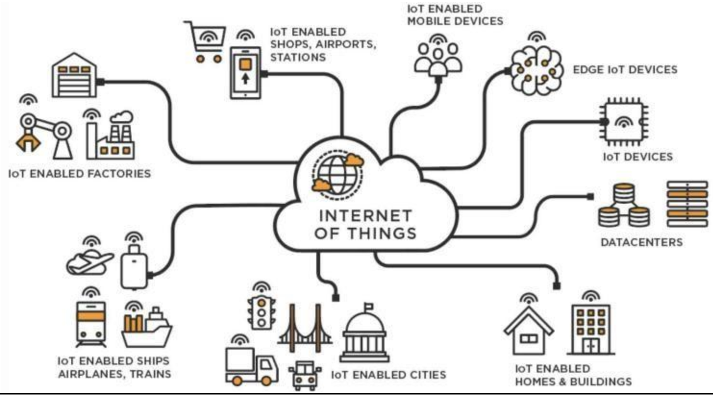
Determining a Repair Plan

The team at PT. PPA Jobsite SKS is focusing on digitizing pump operations for remote monitoring to reduce critical job risks, particularly those associated with dewatering. The goal is to lower the frequency of manual pump operations in the sump, with the target to implement this system by Week 1-2 of 2024, under the leadership of Mirza and Fikri. However, a key challenge identified is the lack of supporting equipment or technology for remote pump monitoring. To address this, an IoT-based monitoring system will be introduced by Week 3 of December 2024, enabling real-time monitoring and automatic data retrieval, eliminating the need for direct intervention. Additionally, a digital dashboard or mobile application will be created by Week 4 of December 2024 for operational teams to access data for analytics purposes. Another critical issue is the absence of a real-time measurement of the water sump's elevation, which is necessary for emergency response. To mitigate this, a sump water elevation sensor will be installed by Week 1-2 of 2024 to provide early warnings, ensuring more effective management of potential emergencies.

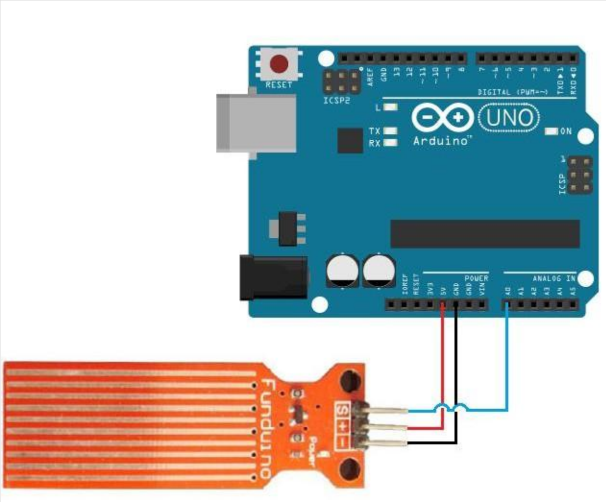
Documenting the Improvement Plan

Table 5. Improvement Plan Documentation

Cause 1 – Alternative 1	
Why	Dewatering work (pump operation) is carried out by crossing Sump each shift
What	The risk of critical work nearby can be lowered by lowering the frequency Sump Packing
Where	PT. PPA Jobsite SKS
When	Week 1-2 December 2024
Who	Mirza & Fikri
How Much (Effort)	IDR 3,000,000
How	Digitization of pumps for remote operation
Illustration	
Cause 2 – Alternative 1	
Why	There is no supporting equipment/technology available for pump monitoring remote
What	Monitoring results can appear automatically so that there is no need to take Direct data on the pump in the sump
Where	PT. PPA Jobsite SKS
When	Week 3 December 2024
Who	Mirza & Fikri
How Much (Effort)	IDR 5,000,000
How	Implementation of an IoT-based monitoring system for real-time monitoring of conditions Pump

Illustration	

Cause 2 – Alternative 2	
Why	There is no supporting equipment/technology available for pump monitoring remote
What	Operations teams need data quickly for analytics needs Mining Progress
Where	PT. PPA Jobsite SKS
When	Week 4 December 2024
Who	Mirza & Fikri
How Much (Effort)	IDR 10,000,000
How	Creation of a digital dashboard or mobile application for *real-time monitoring*
Illustration	
Cause 3 – Alternative 2	
Why	The critical limit of the elevation of the water sump is not measured in real time
What	Response to changes in water sump elevation can be done quickly
Where	PT. PPA Jobsite SKS
When	Week 4 December 2024
Who	Mirza & Fikri
How Much (Effort)	IDR 2,000,000
How	Installation of a sump water elevation sensor that provides early warning Automatic

Illustration	

Source: Project planning documentation by Mirza & Fikri, 2024

Preparing Implementation Competencies, Tool and Material Needs

Table 6. Competencies, Tools, and Material Needs

Competencies	**To support the implementation of work on project improvement carried out by the Perfect team, human resources with standards of competence are needed in fire control and digital system design. Our cluster has met the necessary criteria.**
Tools	Solar Panel
	MPPT Controller
	Mobile
	Computer/Laptop
Material	Accu Battery
	Arduino UNO
	Sensor Ultrasonic
	Rainfall Sensor
	Sensor Water Level
	Red Lamp Indicator
	Website IoT
	Relay Components

Source: Project resource planning by the research team, 2024

Implementing an Upgrade Plan

a. Instalasi Library Arduino
   - Install ESPAsyncWebServer, WiFi, and Adafruit_SensorSiapkan Devices and Sensors
   - Install MQTT

b. Basic Configuration in Arduino IDE

```
#include <WiFi.h>
#include <PubSubClient.h>

const char* ssid = "NAMA_WIFI";
const char* password = "PASSWORD_WIFI";
const char* mqtt_server = "192.168.1.100";  // IP Broker MQTT

WiFiClient espClient;
PubSubClient client(espClient);
const int relayPin = 25;
const int sensorPin = 34;

void setup() {
  pinMode(relayPin, OUTPUT);
  digitalWrite(relayPin, LOW);
  Serial.begin(115200);
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) delay(500);
  client.setServer(mqtt_server, 1883);
}

void loop() {
  if (!client.connected()) reconnect();
  client.loop();

  int value = analogRead(sensorPin);
  if (value > 100) {
```

Figure 7. Basic Configuration in Arduino IDE

Source: System development documentation, 2024

c. Instal Smart Iot Control – Multiflow on/off Monitoring System (SIC-MUFS)

- Perakitan Controller Board Arduino

Figure 8. Controller Board Arduino Assembly

Source: System development documentation, 2024

- Rainfall and Water Level Sensor Assembly

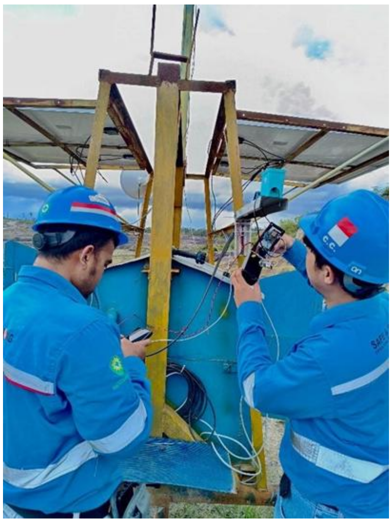


Figure 9. Rainfall and Water Level Sensor Assembly

Source: System development documentation, 2024

- Configuration of Arduino to Controller of the K27 Telemetry pump unit

Figure 10. Configuration of Arduino to K27 Telemetry Pump Controller
Source: System development documentation, 2024

d. Advanced Monitoring and Setup

- Sensor visualisasi *assembling*

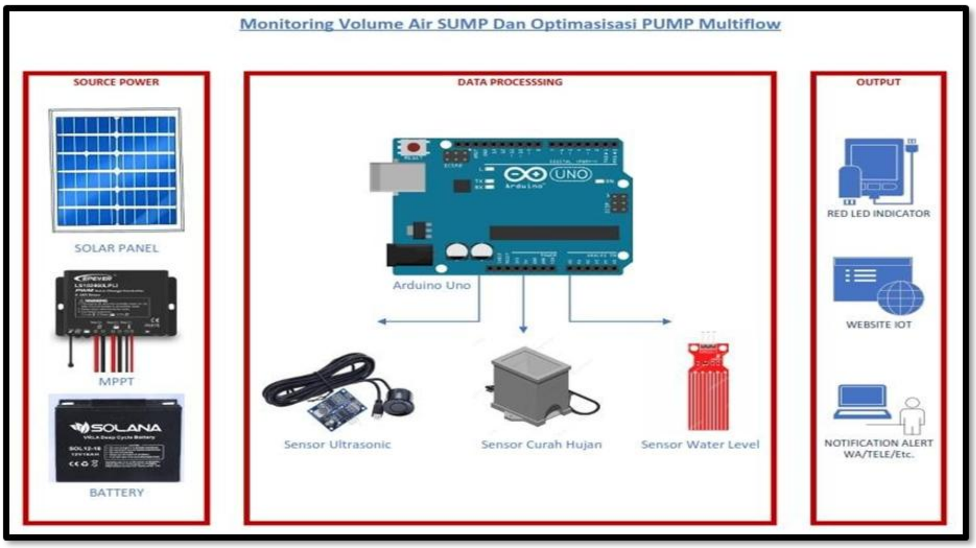
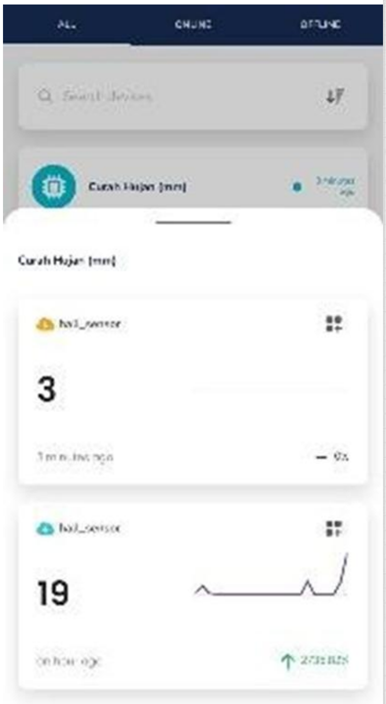


Figure 11. Sensor Visualization Assembly
Source: System development documentation, 2024

e. Creation of the SIC-MUFS Monitoring Dashboard



timestamp	created_at_raindrop	context_raindrop	raindrop	date (Asia/Jakarta)
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1,74E+12	1,74E+12	{}	01.00	2024-12-27 11:40:35.355000+07:00
1,74E+12	1,74E+12	{}	01.00	2024-12-27 11:35:34.428000+07:00
1,74E+12	1,74E+12	{}	01.00	2024-12-27 11:30:31.309000+07:00
1,74E+12	1,74E+12	{}	01.00	2024-12-27 11:25:28.279000+07:00
1,74E+12	1,74E+12	{}	01.00	2024-12-27 11:15:20.587000+07:00
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1,74E+12	1,74E+12	{}	01.00	2024-12-27 07:18:21.665000+07:00
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1,74E+12	1,74E+12	{}	01.00	2024-12-27 07:03:16.483000+07:00

Figure 12. SIC-MUFS Monitoring Dashboard Interface
Source: System development documentation, 2024

Monitoring Implementation Progress

Monitoring is carried out after *the Smart IoT Control – MultiFlow On/Off Monitoring System* (SIC-MUFS) is installed on the multiflo pump, precisely starting from December 26, 2024 – February 28, 2025. The monitoring carried out includes the impact on critical work near water, obstacles to operating the pump remotely, the accuracy of water elevation and rainfall readings, and the speed of data transmission to CCR. The number of critical near-water works during the implementation of the repairs is as follows:

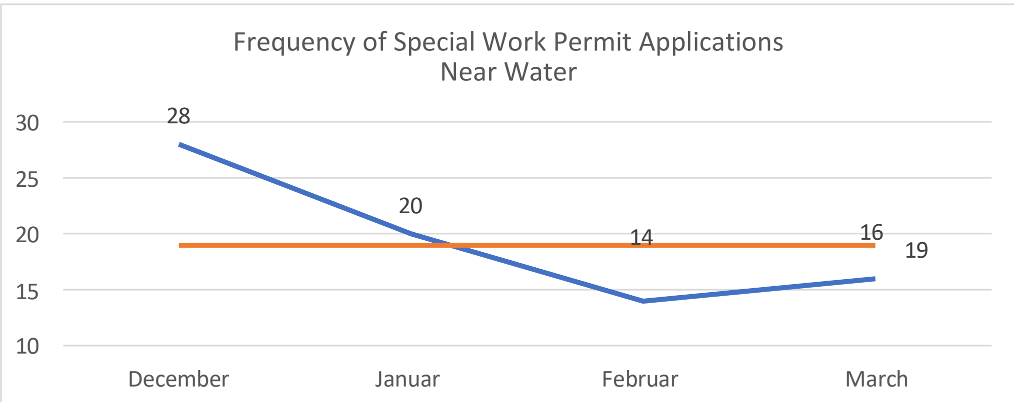


Figure 13. Frequency of Critical Work Near Water during Repair Implementation
Source: Monitoring data from December 26, 2024 – February 28, 2025

At the deadline for monitoring the progress of implementation, there are several conditions where remote pump operation is experiencing problems, including:

a) Unreadable flow sensor

Causes :

Mud that is too thick or contains large particles can interfere with the performance of the flow sensor (especially paddlewheel or turbine type), so the sensor can be closed.

Impact :

The dashboard shows the OFF status even though the pump is on → false reading.

b) Blockages in the Flow Path

Causes :

Sludge deposits accumulate in the pipes or in the input/output of the pump. Impact :

- The flow is obstructed → the sensor does not read the flow → the system is considered OFF.
- The pump can work in dead-head conditions (rotating but no flow)

c) Overheat on Multiflo Pump

Causes :

The heavy and thick sludge puts more load on the pump motor. Impact :

The overheat pump → automatic protection is active → the system shuts down suddenly.

d) Pump Impeller Damage

Causes :

Hard particles in the mud (sand, gravel) can erode or damage the impeller. Impact :

Pump efficiency decreases → unstable flow → fluctuating monitoring data.

e) Corrosion and Abrasion on Pump Components

Causes :

Sludge can be corrosive depending on its composition. Impact :

Sensors are quickly damaged, cables are corroded, pumps are worn.

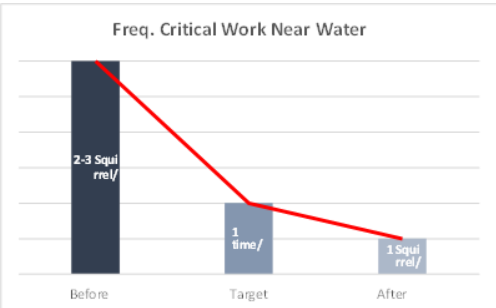
However, these constraints do not significantly interfere with the operation of the pump. The team is currently continuing to develop so that obstacles to the application of SIC-MUFS can be overcome.

Monitoring Progress Improvements

Based on the results of monitoring conducted from December 26, 2024 – February 28, 2025, Smart IoT Control – MultiFlow On/Off Monitoring System (SIC-MUFS) is fairly effective in terms of optimizing dewatering management, so that performance becomes more productive and reduces the potential for near-water work accidents. Therefore, it can be concluded that the improvements that have been made are SUCCESSFUL.

Analysis of Improvement Results

Achieving the Target of Reducing the Frequency of Critical Work Near Water



Remarks	Frequency
Before Repair	2-3 times/day
Target Sasaran	1 time/day
After Repair	1 time/2 days

Figure 14. Critical Work Frequency Decrease Graph near water

Source: Post-implementation performance analysis, 2025

The Perfect team successfully achieved the target of decreasing the frequency of critical work near the water

Reviewing the Impact of QCPSDM

Table 7. Impact of QCPSDM

Aspects	Qualitative	Quantitative	
		Before Repair	**After Repair**
Q (Quality)	The development of technology in pumps has an impact on optimizing the performance of dewatering management	Operation & monitoring is done manually	The operation of the pump is carried out remotely and monitoring becomes real-time
C (Cost)	Eliminate potential losses due to coal hauling being hampered due to the road being submerged in runoff from the sump	Coal Hauling was hampered due to flooded roads 8 times Events	No cases of Coal Hauling being hampered due to flooded roads
P (Productivity)	Pump operation by the Pit Service team becomes faster	Pump operation is carried out manually	Pump operation is carried out remotely
	Prevent flooding in Road Coal Hauling	Flooded on the road Hauling	Flooded tidak occurs
S (Safety)	Reduce the frequency of critical work near water in dewatering management activities	Frequency of critical work near water as much as 2-3 times/day	Frequency of critical work near water as much as 1-2 times/2 happy
D (Deliver)	Monitoring References Related pumping (elevation, precipitation, HM, etc.) becomes more real-time	Data retrieval done manually	Data is recorded in real-time
M (Moral)	Increase the safety of the Pit Service team in dewatering management work	The Pit Service team does a critical job almost every shift	Pit Service team doing critical work 1 kali/2 shift

Source: Performance evaluation before and after SIC-MUFS implementation, 2025

Stakeholder Impact Review

Table 8. Stakeholder Impact

No	Stakeholder	Capabilities	Impact After Repair
1	The Board of Directors of PT. PPA	Company Leader	Satisfaction with safety performance in control *high Risk. activity* with *Improving* Digital Transformation Approach
2	The management of PT. PPA Site SKS	Pimpinan Site	Site management is greatly helped by the improvement of SIC-MUFS, because in addition to reducing the risk of accidents, *these tools* have an impact on Increased Productivity of Operational Performance
3	**PT. Credits**	**Customer**	The existence of SIC-MUFS increases satisfaction assessments Customers especially on Aspects safety, operations and *improvement*

Source: Stakeholder feedback and impact assessment, 2025

Benefits

a. Benefits to the Company

- There is a decrease in the frequency of critical work near water from 2-3 times/day to 1 time/day, thus reducing the risk of mine accidents.
- There is no potential loss due to flooded roads due to dewatering management failure.
- Delivery data monitoring pumping becomes more and pit service becomes more productive.

b. Other Benefits

- Problem-solving methods can be applied to a variety of different industry areas.
- It can add to the treasures of science by making this paper a reference in dewatering management.

c. Benefits to the Cluster

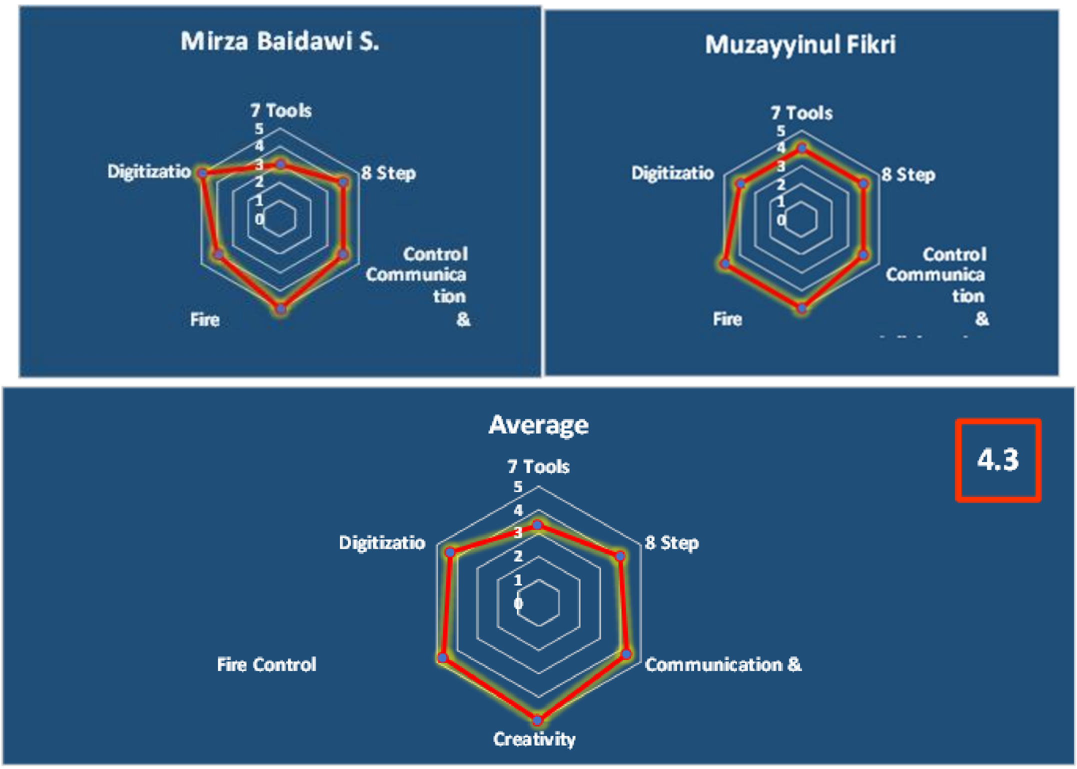


Figure 15. Cluster Competency Improvement Visualization
Source: Internal cluster assessment results, 2025

Table 9. Competency Improvement Assessment

Period	Value Criteria	Aspects
1	Do not understand yet	**7 Basics Tools of Quality**
2	Just Understanding	**8 PDCA Steps**
3	Understanding the Need for Guidance	**Communication and Cooperation**
4	Understanding and Being Independent	**Creativity**
5	Understand and Can Teach	**Fire Control**
		Digitization

Source: Internal cluster assessment results, 2025

There was an increase in the average competence of group members from **3.0** to **4.3**.

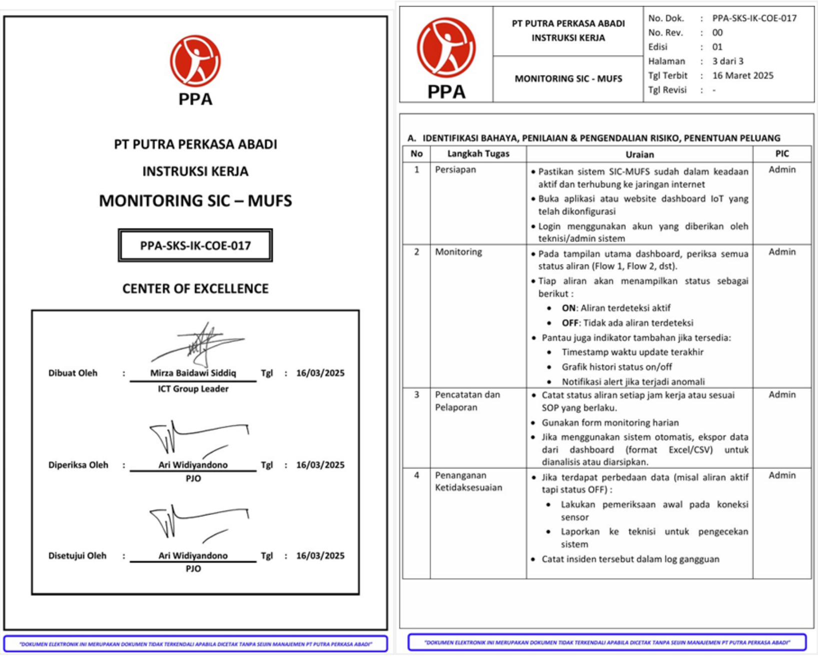
Input Standards

Table 10. Input Standards

Description	Paramater	Remarks
Tools	Smart IoT Control – MultiFlow On/Off Monitoring System (SIC-MUFS)	**Multiflo Pump Digitization**
Media	Handphone & Monitor	**Remote & Notifications**
PIC	**Production (Pit Sevice) & COE**	**-**

Source: Standardization documentation for SIC-MUFS implementation, 2025

Process Standards



PPA

PT PUTRA PERKASA ABADI
INSTRUKSI KERJA
MONITORING SIC – MUFS

PPA-SKS-IK-COE-017

CENTER OF EXCELLENCE

Dibuat Oleh : Mirza Baidawi Siddiq, ICT Group Leader — Tgl : 16/03/2025
Diperiksa Oleh : Ari Widiyandono, PJO — Tgl : 16/03/2025
Disetujui Oleh : Ari Widiyandono, PJO — Tgl : 16/03/2025

"DOKUMEN ELEKTRONIK INI MERUPAKAN DOKUMEN TIDAK TERKENDALI APABILA DICETAK TANPA SEIJIN MANAJEMEN PT PUTRA PERKASA ABADI"

PPA — PT PUTRA PERKASA ABADI, INSTRUKSI KERJA — MONITORING SIC - MUFS

No. Dok. : PPA-SKS-IK-COE-017
No. Rev. : 00
Edisi : 01
Halaman : 3 dari 3
Tgl Terbit : 16 Maret 2025
Tgl Revisi : -

A. IDENTIFIKASI BAHAYA, PENILAIAN & PENGENDALIAN RISIKO, PENENTUAN PELUANG

No	Langkah Tugas	Uraian	PIC
1	Persiapan	• Pastikan sistem SIC-MUFS sudah dalam keadaan aktif dan terhubung ke jaringan internet • Buka aplikasi atau website dashboard IoT yang telah dikonfigurasi • Login menggunakan akun yang diberikan oleh teknisi/admin sistem	Admin

2	Monitoring	• Pada tampilan utama dashboard, periksa semua status aliran (Flow 1, Flow 2, dst).
		• Tiap aliran akan menampilkan status sebagai berikut :
		  • **ON**: Aliran terdeteksi aktif
		  • **OFF**: Tidak ada aliran terdeteksi
		• Pantau juga indikator tambahan jika tersedia:
		  • Timestamp waktu update terakhir
		  • Grafik histori status on/off
		  • Notifikasi alert jika terjadi anomali
			Admin

3	Pencatatan dan Pelaporan	• Catat status aliran setiap jam kerja atau sesuai SOP yang berlaku. • Gunakan form monitoring harian • Jika menggunakan sistem otomatis, ekspor data dari dashboard (format Excel/CSV) untuk dianalisis atau diarsipkan.	Admin

4	Penanganan Ketidaksesuaian	• Jika terdapat perbedaan data (misal aliran aktif tapi status OFF) :
		  • Lakukan pemeriksaan awal pada koneksi sensor
		  • Laporkan ke teknisi untuk pengecekan sistem
		• Catat insiden tersebut dalam log gangguan
			Admin

"DOKUMEN ELEKTRONIK INI MERUPAKAN DOKUMEN TIDAK TERKENDALI APABILA DICETAK TANPA SEIJIN MANAJEMEN PT PUTRA PERKASA ABADI"

Figure 16. SIC-MUFS Monitoring Work Instructions

Source: Standard operating procedure (SOP) documentation, 2025

Output Standards

Dewatering management becomes more optimal

Socialization of New Standards

Table 11. Socialization of New Standards

No	Date	Location	Time	Personnel
1	March 10, 2025	CMC	04.00 PM	**COE**
2	**March 15, 2025**	**CMC**	**04.00 PM**	**COE**

Source: Internal communication and training schedule, 2025

Figure 17. Socialization of New Standards
Source: Documentation of socialization sessions, 2025

Problem Identification

After implementing and evaluating the repairs, the critical work near water, particularly pump operations in the sump, significantly decreased, reducing the risk of mining accidents in these activities. However, while developing SIC-MUFS, the team discovered a new issue: the mining roads were not up to standard. The mining axis road connecting the pit and disposal area at PT. PPA Site SKS suffered severe damage due to previous dewatering management problems. Although road conditions have improved alongside better dewatering management, the issue remains unresolved. Poor road management impacts both safety and operational productivity, as mining activities primarily take place in the road area. In the first quarter of 2025, most incidents at the SKS PPA Site occurred in the mining road area, and data from the Hazard Report indicated that the most common non-conformance issue over the past three months was "Non-Standard Road Conditions."

Table 12. Hazard Report Recapitulation January – March 2025

NO	REPORT TYPES	QUANTITY
1	Non-Standard Road Conditions	**305**
2	Misplacement/Placement	**114**
3	Non-Standard Equipment	**66**
4	Non-Standard Front	**34**
5	B3 Spills/Spills	**24**
6	**Hanging Rocks (Landslide-Prone)**	**17**

Source: PT. PPA Jobsite SKS Hazard Report Database, 2025

Problem Stratification

Table 13. Problem Stratification

No	Problems	Quantity	Cumulative Amount	Presentase (%)	Cumulative Percentage (%)
1	Non-Standard Road Conditions	305	305	54.5	**54.5**
2	Misplacement/Placement	114	419	20.4	**74.8**
3	Non-Standard Equipment	66	485	11.8	**86.6**
4	Non-Standard Front	34	519	6.1	**92.7**

5	B3 Spills/Spills	24	543	4.3	**97.0**
6	Hanging Stone (Cartilage Landslide)	17	560	3.0	**100.0**
	TOTAL	**560**	**-**	**100.0**	**-**

Source: Analysis of Hazard Report data (January – March 2025)

Prioritizing Issues

Based on the results of identifying problems in operational safety aspects using Hazard Report data in the period of January – March 2025, we explain these problems using a pareto diagram so that the most dominant problems can be identified:

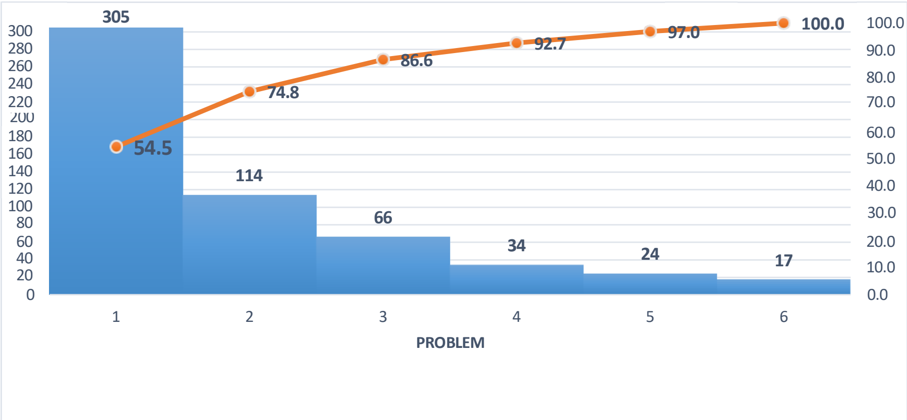


Figure 18. Pareto Priority Problems

Source: Analysis of Hazard Report data (January – March 2025)

Defining a Theme

After identifying the issues to be addressed, the team chose the theme "Improving the Quality of Mining Road Management at PT. PPA Jobsite SKS." This decision was based on several key factors: mining roads are the most frequent locations for incidents, both near-misses and accidents; the highest number of unsafe conditions and actions during the first quarter of 2025 were found in the mining road area; and the quality of mining roads significantly impacts not only operational safety but also the productivity of hauler units (Dump Trucks) in mining operations.

Defining Theme Goals

Remarks	*Hazard Report*			Total Case
	Jan	Feb	Mar	
Actual	99	102	104	305
	Jul	Ags	Sep	
Objectives	50	50	50	150

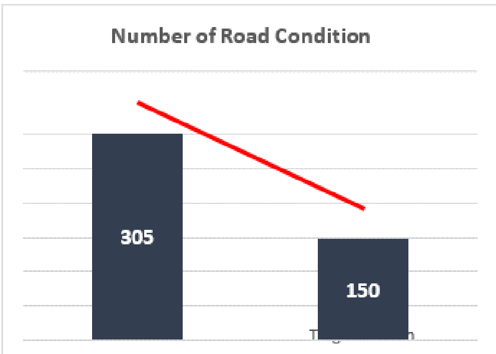


Figure 19. Theme Goal Definition and Target Setting

Source: Team analysis and target setting for the next improvement cycle, 2025

CONCLUSION

The Perfect Team targeted a 50% reduction in unsafe condition or action reports in the Jalan Tambang area compared to Q1 2025 actuals, recognizing these as initial symptoms—or "first dominoes"—in the Domino Incident Theory that precede accidents and losses, thus necessitating improved mine road management to prevent incidents. To achieve this, the company should not only consolidate SIC-MUFS system gains through ongoing socialization and standardization but also swiftly enhance mining road quality via a technology- and data-driven approach, adapting proven digitalization and risk management principles from the dewatering project to foster safer, more efficient, and sustainable operations amid climate change challenges. For future research, a comparative study could evaluate the efficacy of IoT-based monitoring systems (like SIC-MUFS) applied to mine road maintenance, quantifying reductions in unsafe reports, accident rates, and operational costs across multiple sites.

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