World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

Environmental protection, health, and occupational safety initiatives: Reducing filter waste and environmental contamination from oil leaks in coal mining excavators

Agus Amirudin [1,*], Zulkarnaen [2], Gunawan [3] and Agy Sugiyatno [4]

[1] *Section Head SHE of PT. Antareja Mahada Makmur site PT. Multi Harapan Utama.*
[2] *Operational Responsible Person of PT. Antareja Mahada PT. Makmur site Multi Harapan Utama.*
[3] *Head PLANT Department of PT. Antareja Mahada Makmur PT. site Multi Harapan Utama.*
[4] *Section Head Production of PT. Antareja Mahada Makmur PT. site Multi Harapan Utama.*

World Journal of Advanced Research and Reviews, 2024, 24(01), 2509–2520

Publication history: Received on 17 September 2024; revised on 24 October 2024; accepted on 26 October 2024.

Article DOI: https://doi.org/10.30574/wjarr.2024.24.1.3284

Abstract

Background: Hazardous and toxic waste contamination in the mining industry is primarily generated from the servicing and maintenance of heavy equipment. One of the key issues in this process is hydraulic oil leaks in excavator units. Additionally, the use of B30 fuel impacts the filter replacement interval, as its lifetime is shorter, thereby contributing to the amount of hazardous and toxic waste. Based on data obtained during the August-November 2023 period, hydraulic system leaks amounted to 4,899 liters. The aim of this study is to assess the implementation of improvement plans aimed at reducing filter waste and environmental contamination caused by oil leaks in excavators.

Method: This study is a descriptive quantitative analysis aimed at describing the impact of strategies implemented to reduce filter waste and environmental contamination caused by oil leaks in excavators. The research was conducted at PT. Anteraja Mahada Makmur (PT. AMM) on the jobsite of PT. Multi Harapan Utama (PT. MHU) from August 2023 to March 2024. The variables studied included strategic steps composed of alternative solutions, which serve as the foundation for planning the repair of oil leaks and engine filter damage. The population of the study encompasses all maintenance activities within the company, involving personnel, materials, environment, machinery, and methods. The sample focuses specifically on maintenance activities involving factors that experience deviations, such as personnel, machinery, and methods.

Results: The implementation of the improvement plan consists of creating a Standard Form for Follow up suggestion, Creating a special Group for equipment health, Adding a discussion of Plant service H+2 and details of Follow up Equipment Health activities, Cleaning the radiator every 6000 hours by lowering it, Activating tropical spec (+55 degrees) by jumpering CN05 Controller Pump, Installing additional filters to reduce the load on the main filter, Creating Guidance PPM (Machine Inspection Program) and Standardizing Hydraulic Pressure, Sharing Knowledge related to the Hydraulic System, Rebuilding existing tools with available materials, Installing Autodownload VHMS on the Big Digger unit, Developing SS6 for web-based data processing.

Conclusion: The implementation of the improvement plan strategy carried out at PT. AMM Site MHU went well and showed maximum results. This can be seen from the positive changes for all elements targeted for improvement (man/workers, machines and methods) which generally have an impact on reducing engine filter waste and environmental contamination due to oil leaks in the excavator unit.

Keywords: Hydraulic Oil Leakage; Filter Machine; Excavator

* Corresponding author: Agus Amirudin

1. Introduction

Mining has become one of the key drivers of economic growth in various countries, including Indonesia (1) . The presence of mining management in Indonesia has brought many benefits, such as increased job availability for the local population, particularly for residents in areas near mining sites. Additionally, significant income for the Indonesian government is generated through taxes, profit sharing from companies, and dividends that companies must provide as a result of managing the country's natural resources (2).

However, alongside the increasing development of mining in Indonesia, particularly in Kalimantan, there are concerns about the significant negative impacts on the environment at mining locations. Mining activities involve the use of many chemicals that can be harmful to the soil, water, and air surrounding the mining sites (3). Although all mining activities are conducted in accordance with good safety standards, there remains the possibility of obstacles, such as damage to the equipment used during the mining operation process.

To minimize these potential risks, the implementation of the SMART Safety concept is essential. SMART Safety emphasizes the importance of a safety plan that is specific, measurable, achievable, relevant, and time-bound. In the mining context, specific actions, such as routine equipment checks to detect oil leaks or damage to hydraulic systems, are crucial. Each preventive measure must be measurable, for instance, through incident recording and periodic maintenance that are regularly monitored and evaluated. By ensuring that all procedures can be realistically achieved with the available technology and resources, mining companies can maintain the relevance of their safety programs to daily operations. Finally, each step must have a clear time frame, such as weekly or monthly inspections, to ensure that safety is continuously monitored and evaluated.

By implementing SMART Safety, mining companies not only enhance environmental safety but also improve operational efficiency and occupational health, reduce the risk of accidents, and ensure the long-term sustainability of mining activities. Additionally, the Mineral and Coal Mining Safety Management System Audit aims to provide an overview of the level of implementation of the mineral and coal mining safety management system. It assesses the mining system's ability to comply with relevant laws and regulations, evaluates the effectiveness of the system in achieving established targets, and identifies potential areas for improving the Mineral and Coal Mining Safety Management System(3). Worker awareness and involvement in Occupational Health and Safety (OHS) management have begun to shift the management approach from a purely top-down model to one that encourages two-way communication. This means that all levels of staff actively participate in efforts to create a safe, comfortable, healthy, and secure work environment. Conversely, there is a need for increased efforts to optimize supervision and develop innovative programs aimed at minimizing unsafe actions and conditions in the workplace (3) . In general, it is important to note that improving the implementation of the Occupational Health and Safety (OHS) Management System is a continuous effort that involves all levels of the organization. With the active participation of all stakeholders, it is hoped that the safety program can be continually enhanced to optimize workplace safety standards (4) .

PT. Anteraja Mahada Makmur jobsite PT. Multi Harapan Utama is one of the companies engaged in coal mining located in East Kalimantan. One of the heavy equipment that is the main vehicle during the coal mining process is the excavator unit. Due to its very frequent use, the possibility of damage to the excavator will be greater, so extra care and maintenance are needed. A common problem during the use of excavators is hydraulic oil leaks. Hydraulic oil leaks that have been going on for the past few months. Data obtained from the company shows that the oil leak is 4,899 liters. This number is the result of the accumulation of the duration of the incident, which is 288 hours and a frequency of 94 times over a period of 3 months, from August to October 2023. The leak resulted in a loss of IDR 650,829,600 for the company. In addition to these economic losses, other losses will have an impact on environmental damage because used oil is included in the Hazardous and Toxic Materials waste category.

Another problem that is also a concern for the company in addition to the problems explained previously, is the use of B30 fuel in excavator units which causes a short service life on the engine filter so that the filter replacement interval will be shorter. Even replacement can occur outside the planned schedule. The short interval will have an impact on the increasing amount of Hazardous and Toxic Materials waste generated from repair and maintenance activities, which in the end if excessive Hazardous and Toxic Materials waste will have an impact on the contamination of the environment around the mining area.

The issues that arose had a significant impact on the company's performance, as assessed by the achievement of Key Performance Indicators (KPIs). Data obtained from the KPI report for AMM Site MHU for August to October 2023 indicated that two KPIs were not met. First, the Mean Time Between Failure (MTBF) averaged 58 hours, which is below the target of 72 hours. Second, the Repair and Maintenance Cost (RM Cost) was 35.06%, exceeding the maximum target of 27%. Based on the description of the problems presented, the researcher aims to explore strategies that can be implemented to reduce filter waste and minimize environmental contamination caused by oil leaks in excavator units.

2. Material and methods

This study employs a quantitative descriptive method to examine the strategies that can be implemented to reduce engine filter waste and environmental contamination caused by oil leaks in excavators. Additionally, qualitative research is utilized to describe phenomena based on the facts observed in the field (5).

This study was conducted at PT. Anteraja Mahada Makmur, specifically site PT. Multi Harapan Utama site, from August 2023 to March 2024. The variables examined included strategic steps consisting of alternative solutions, which will serve as the foundation for a plan to address oil leaks and engine filter damage. The population of this study encompasses all maintenance activities within the company, involving workers, materials, the environment, machines, and methods. The research sample focused specifically on maintenance activities that exhibited deviations related to human resources, machinery, and methods.

The data used in this study includes both primary and secondary data from PT. AMM Site MHU. Primary data consists of direct observations of the excavator units during operation and maintenance, while secondary data includes periodic reports and analysis conducted by PT. AMM Site MHU employees regarding the company's KPI achievements. Data analysis is performed by presenting the information in the form of tables, graphs, and diagrams related to improvement plans and their outcomes.

3. Results

Oil leaks and filter waste significantly impact all maintenance activities and the supporting factors involved in maintenance. These factors include human resources, materials, environment, machinery, and methods. The initial step taken by the researcher was to identify the root causes of low KPI achievement at PT. Anteraja Mahada Makmur, Site MHU. After completing the identification process, six key problems were identified that require solutions to reduce filter waste and hydraulic oil leaks. These six identified problems are presented in Table 1.

Table 1 Problems Occurring in the Maintenance Process at PT. Anteraja Mahada Makmur, Site MHU

No	Factor	Problem	Root Cause	Information
1	Man	Not all follow-up findings from the health unit can be completed	There is no receptacle coordination in place yet.	It is suggested to follow up without using documents, relying solely on personal communication tracking.
2	Machine	Frequent hydraulic system leaks occur.	The radiator is clogged.	All Big Digger units experience deadlock on radiator fin and oil cooler
			Elevated ambient temperature	The average ambient temperature is 60°C
3	Machine	Frequent occurrences of unscheduled breakdowns (BUS) due to engine low power	The engine fuel filter is clogged, causing the engine to overheat.	The engine's operational life is 100-150 hours, which falls short of the recommended service interval, leading to unscheduled breakdowns (BUS) and low engine power.
4	Machine	The hydraulic system pressure does not meet the standards specified in the shop manual	Adjustments were not made during the Planned Preventive Maintenance (PPM)	The pressure of the Main Relief and OLSS systems is outside the standards specified in the shop manual
5	Machine	Fuel system flushing has not been performed	The flushing tool is damaged	2 units of track-type flushing tools are damaged and cannot be used again.

6	Method	The follow-up has not been completed	VHMS data is not downloaded daily	Data is downloaded manually, which prevents the retrieval of data for all units on a daily basis
			The processing of unit health data takes a significant amount of time	Manually processing the health data for all 16 Big Digger units takes approximately 8-9 hours

Source: Secondary Data, 2023

After identifying the root causes of the problems, the researcher proceeded to create a repair plan for each issue. The repair plan is outlined in Table 2.

Table 2 Alternative solutions are proposed as part of the repair plan

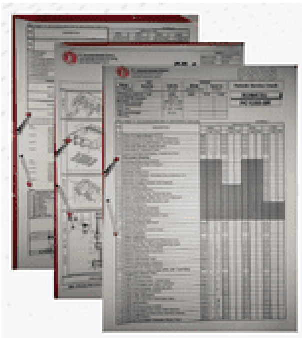
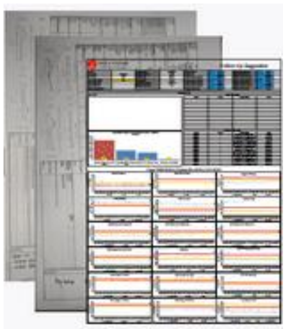
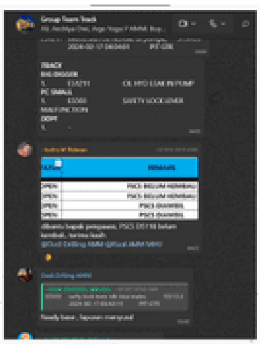
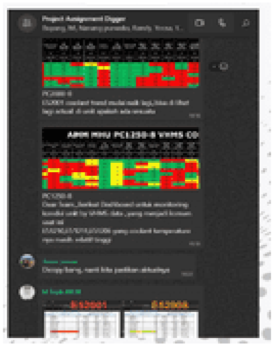
No	Problem	Alternative Solutions	Reason	Location	Solution Estimation
1	There has been no follow-up coordination regarding the receptacle	Developing a standardized form for follow-up suggestions	To serve as a communication tool and historical record in hardcopy form	Workshop	Cost: IDR 0 Lead Time: <24 hours Impact: Establishes a standard suggestion form and historical follow-up process Effectiveness: Very effective
		Establish a dedicated group for health equipment management	The field and back office teams have developed strong chemistry	Workshop	IDR 0
		Incorporate a plant service discussion on H+2, along with detailed equipment health follow-up activities.	This ensures that parts, manpower, and special tools can be properly prepared	Meeting Room	IDR 0
2	Radiator clogged	Clean the radiator every 6000 hours using the method of removal for thorough maintenance	Clear the clogged radiator to prevent the working temperature of the equipment from becoming excessively high or overheatin	Service location	IDR 30,000,000
3	Elevated ambient temperature	Activate the tropical specification (+55 degrees) using the CN05 controller pump jumper method	Increase fan speed electrically to reduce the impact of ambient temperature on the working temperature	Big Digger Unit	IDR 0
4	The engine fuel filter is clogged, causing the filter material to become blocked	Install additional filters to reduce the load on the main filter	Avoid clogged fuel filters to prevent insufficient fuel supply and maintain optimal engine performance	Big Digger Unit	IDR 1,000,000 / unit
5	No adjustments were made	Develop a PPM guidance and hydraulic	This will help mechanics better understand how to	Workshop	IDR 0

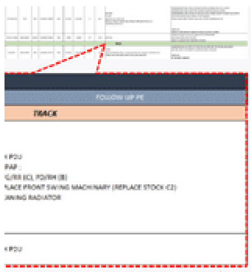
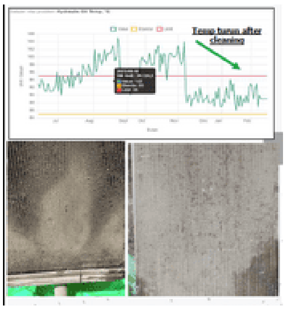
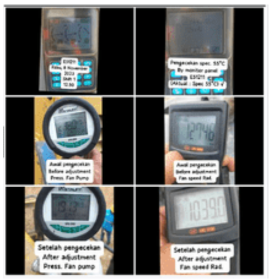
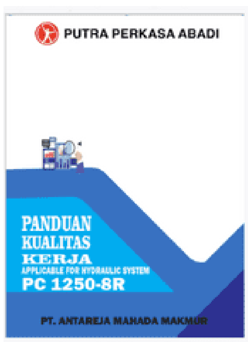
	during the Planned Preventive Maintenance (PPM)	pressure standardization procedure	properly test and adjust the hydraulic system effectively and accurately		
		Conduct a knowledge-sharing session related to hydraulic systems	Ensure knowledge equalization across all teams	Workshop	IDR 0
6	The flushing tool is damaged	Rebuild the existing tools using available materials	This ensures that the fuel in the unit's fuel tank maintains a higher level of cleanliness	Workshop	IDR 5,000,000
7	VHMS data is not downloaded daily	Install an autodownload system for VHMS data on the Big Digger unit	This ensures that all VHMS unit data can be downloaded easily and quickly	Workshop	IDR 0
8	Processing historical unit health data	Develop an SS6 system for web-based data processing	This will reduce the time engineers spend on data processing, allowing them to dedicate more time to data analysis and providing technical support in the field	Workshop	IDR 0

Source: Secondary Data, 2023

After determining the alternative solutions, the next step is the implementation of the repair plan. Presented here is a comparison of the results before and after the planned improvements have been implemented.

Table 3 Implementation Plan Repair

No	**Alternative Solutions**	**Before**	**After**	**Impact**
1	Develop a standardized form for follow-up suggestions			All follow-ups are documented more thoroughly and effectively
2	Establish a dedicated group for managing health equipment			All follow-ups are completed with improved and comprehensive documentation

No	Alternative Solutions	Before	After	Impact
3	Include a plant service discussion on H+2 along with detailed follow-up activities for equipment health			All follow-ups are conducted properly and efficiently
4	Clean the radiator every 6000 hours using the removal method for more thorough maintenance			The temperature returns to normal operating levels
5	Activate the tropical specification (+55 degrees) using the CN05 controller pump jumper method			Reduce the ambient temperature to below 45°C.
6	Install additional filters to reduce the load on the main filter			BUS low power issues are reduced,
7	To develop a comprehensive PPM (Planned Preventive Maintenance) guidance, including an inspection program for the machine and hydraulic pressure standardization, follow these structured steps:	no guide		he hydraulic system pressure complies with the specifications As outlined in the shop manual.

No	Alternative Solutions	Before	After	Impact
8	Conduct a knowledge-sharing session focused on the hydraulic system	Only during product training		Knowledge sharing is limited to product training sessions only
9	Build repeat existing tools with material which are available			The flushing process can done with good and consistent
10	Install the autodownload system for VHMS data on the Big Digger unit			Unit health data is always available, allowing for better monitoring of the unit
11	Develop the SS6 system for efficient web-based data processing, enhancing data management and accessibility			With more time allocated for analysis, greater focus can be placed on follow-up actions in the field

The next step in the strategy to reduce hydraulic oil leakage and filter waste is to conduct an evaluation of the improvement results. The evaluation results are presented in Figure 1.

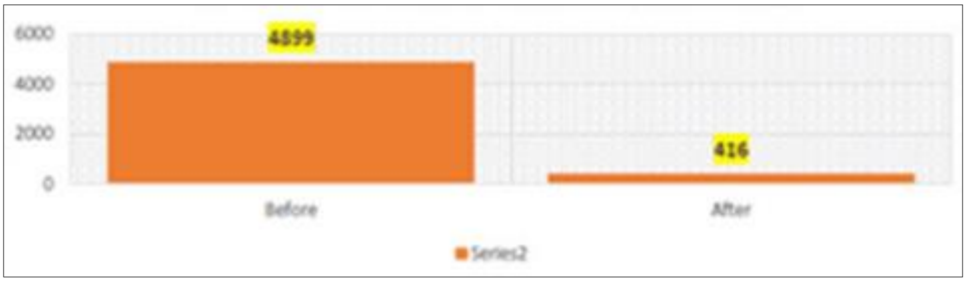


Figure 1 Diagram of Hydraulic Oil Volume Reduction After Repairs

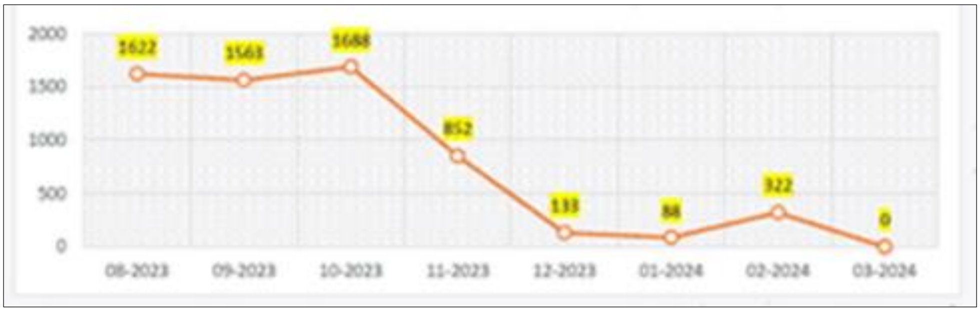


Figure 2 Hydraulic Oil Leakage Volume Chart from August 2023 to March 2024

In Figure 1, it is clearly shown that there is a significant decrease in hydraulic oil volume from 4,899 liters to just 416 liters after the repairs were completed, indicating a reduction in oil waste while the excavator is in use. The volume continued to decrease over time, and by March 2024, it was recorded that there was no further leakage, as the oil volume reached zero.

4. Discussion

Hydraulic oil leaks and filter replacements outside of the scheduled maintenance have become significant issues, impacting both mining operations and the economic performance of the mining company. Frequent hydraulic oil leaks from excavators lead to a substantial amount of oil spilling onto the ground, which can cause environmental contamination and pollution, ultimately damaging the ecosystem in the mining area. Another major concern is the need for unscheduled filter replacements, deviating from the maintenance schedule. This issue arises due to the use of B30 fuel, a type of fuel composed of 30% biodiesel and 70% diesel. The use of B30 fuel has been linked to increased wear on the filters, leading to more frequent replacements outside the planned intervals (6). The use of B30 fuel is a government recommendation as mandated by the Ministry of Energy and Mineral Resources (ESDM) Regulation No. 12 of 2015, which is an amendment to the ESDM Regulation No. 32 of 2008 concerning the Supply, Utilization, and Trade of Biofuels as Alternative Fuels. B30 fuel is considered more environmentally friendly because it contains 30% biodiesel. Biodiesel is produced from vegetable oils or animal fats, such as palm oil, jatropha oil, coconut oil, and fish oil. Although B30 fuel is viewed as more environmentally friendly due to its biodiesel content, the reality in the field shows that its use shortens the service life of machine filters. This results in more frequent filter replacements, often earlier than the scheduled maintenance intervals. If this issue is not addressed, it will ultimately lead to an increase in the amount of hazardous B3 waste in the form of machine filters. These two problems are currently being faced by PT. AMM, resulting in significant financial losses. To mitigate further losses, the company has implemented strategies to reduce these issues.

The first strategy implemented by the company to reduce these issues is to identify the root causes of the problems at PT. AMM, Site MHU. This identification process was carried out across all factors involved in the mining process, including human/employee, materials, environment, machinery, and methods. For each factor, key issues were identified and prioritized for improvement. The prioritization was based on the potential impact on the company, considering both the negative consequences if no improvements were made and the positive effects if quick actions were taken. For the human/employee factor, the issue selected was related to the follow-up on findings from unit health reports. In the machinery factor, the focus was on problems related to hydraulic system leaks, unscheduled breakdowns (BUS) caused by engine low power, and hydraulic system pressure that did not meet the correct standard outlined in the manual. In the method factor, the issue of incomplete fuel flushing and unfinished follow-ups were identified as key problems. Each of these factors was prioritized for corrective actions to minimize the impact on the company's operations and performance.

After determining the priority problems, the second strategy involves designing a repair plan by offering alternative solutions. Each proposed solution is estimated in terms of cost, time required for the repair, potential impact, and effectiveness. An evaluation is conducted for each estimate, and a final decision is made on whether the proposed solutions can effectively reduce or eliminate the identified issues.

In Table 3, three solutions are proposed to address the issue of follow-up coordination related to the receptacle, which had not been previously handled. The first solution involves the creation of a standard form for unit health follow-up, as there had previously been no formal documentation for this process. After implementation, a standard form was introduced, containing detailed information on the unit's health and specific suggestions to address the problems that occurred. The second solution entails forming a dedicated group for equipment health, allowing for more focused and detailed discussions, in contrast to broader conversations in larger groups. The third solution incorporates discussions on future tasks during daily meetings. These meetings now not only review breakdown statuses for the current day but also include plans for up to two days ahead. This ensures better preparation of parts, support tools, and manpower, allowing follow-up activities to be executed effectively and efficiently. The second issue relates to hydraulic system leaks, primarily caused by a blocked radiator and high ambient temperatures, which averaged around 60°C. The solution implemented to tackle this problem involves washing and cleaning the radiator every 6000 hours using a removal method. This strategy has proven effective, as the operating temperature returned to normal levels. Additionally, the fan speed was increased electrically to stabilize the surrounding temperature, helping to further prevent hydraulic system leaks.

The third priority problem identified for repair is the frequent occurrence of unscheduled breakdowns (BUS) due to low engine power or unexpected machine failures caused by clogged engine fuel filters. This issue indirectly affects the achievement of MTBF (Mean Time Between Failure). MTBF refers to the average time interval between failures that occur after a machine or component has been repaired, until it experiences another failure. The MTBF target, which is set as part of the KPI (Key Performance Indicator), is 72 hours. However, in practice, failures are occurring more frequently, with the actual MTBF being only 52 hours, which is significantly below the target (7). To reduce the likelihood of filter damage, an additional filter was installed to decrease the load on the main filter. This was done to prevent the main filter from becoming clogged due to poor fuel quality. The installation of the additional filter has had a positive impact by reducing occurrences of low power BUS (unscheduled breakdowns) and lowering overall filter maintenance costs.

The fourth issue that requires attention is the hydraulic system's pressure not being in accordance with the standard guidelines. This problem arose because there was no proper implementation guide for the Machine Inspection Program (PPM) or a quality manual for hydraulic systems. As a result, a manual titled "Quality Work Guidelines: Applicable for Hydraulic Systems" was created. This guide is designed to be shared with workers, particularly those responsible for regulating hydraulic system pressure, in order to enhance their knowledge and improve the quality of PPM work. Additionally, knowledge sharing on hydraulic systems has become a priority. This is crucial to ensure that workers, such as mechanics and group leaders, have the same level of understanding, which leads to more effective work outcomes. Before this improvement, knowledge sharing was only conducted on an as-needed basis. However, after the implementation of the new guidelines, knowledge sharing is now conducted regularly through P5M meetings, coaching, mentoring, and field guidance sessions. This consistent approach ensures that all personnel are equally informed and capable of performing their tasks to a higher standard.

The next repair to be carried out involves rebuilding the damaged flushing tools. These damaged tools have disrupted the fuel flushing process, which is crucial for maintaining fuel cleanliness. Efforts were made to reconstruct the existing tools using available materials. This repair has had a positive impact, as the flushing process can now be performed effectively and consistently. As a result, the fuel in the fuel tank remains cleaner, ensuring better performance of the equipment. Additionally, improvements were implemented in the VHMS (Vehicle Health Monitoring System). VHMS is a technology used to monitor the health parameters of various machine components, providing data in the form of charts, diagrams, and numerical tables. This system helps analyze the condition of equipment both before and after unscheduled breakdowns, especially for heavy machinery such as dump trucks and excavators. Previously, VHMS data had to be downloaded manually, which made it difficult to retrieve data for all units daily. To address this, an update was introduced by installing the VHMS Autodownload application on Big Digger units. This application allows for automatic daily downloads of unit health data, making it easier for employees to access the information and monitor the health of the equipment more efficiently.

The final implementation focuses on developing a system using the existing SS6 platform. This development was initiated to address the initial problem where unit health data processing was done manually using Ms. Excel. More than 1,000 raw data entries were processed daily, and manual processing led to frequent delays in providing the necessary data. Additionally, the manual approach required a significant amount of time for data processing. To resolve this, a web-based data processing system was developed. The benefits of implementing this system include a significantly shorter data processing time for engineers, allowing them to allocate more time to data analysis and providing technical support in the field. This improvement not only enhances operational efficiency but also enables faster decision-making and response to equipment health issues.

In this context, the implementation of SMART safety principles can be a crucial solution for effectively addressing the issue. Specifically, the SMART safety approach ensures strict monitoring of the hydraulic system to prevent oil leaks at an early stage. Routine inspections and targeted maintenance of vulnerable components, such as hydraulic hoses and connections, can help reduce the risk of leaks. These actions must also be measurable, for instance, by using automatic leak sensors that provide real-time data. This technology can significantly minimize the environmental impact by quickly identifying and addressing leaks, allowing for timely intervention.

This approach must also be achievable through the use of existing technology, such as digital-based monitoring systems, which allow for quick problem resolution. The relevance of this safety program is particularly important, given that the use of B30 fuel has become a national policy. In the long term, through periodic inspections and updates to the filter maintenance program, the company can reduce the frequency of filter replacements and address oil leak issues more efficiently. By implementing SMART safety principles, mining companies can strike a balance between operational demands and environmental responsibility. This ensures that operations continue without causing long-term negative impacts on the surrounding ecosystem. Additionally, it optimizes operational efficiency by reducing costs associated with equipment problems and waste management.

After implementing all the strategic steps, an evaluation was conducted, revealing significant improvements compared to the pre-repair period. Figure 1 shows a drastic reduction in hydraulic oil volume, from 4,899 liters to only 416 liters in the months following the repair. Figure 2 demonstrates a consistent decline in hydraulic oil leakage each month, starting from the identification of the issue in August 2023 until March 2024. The data from March 2024 indicates zero leakage, signifying that no hydraulic oil leaks occurred in that month.

The evaluation also highlighted the benefits of applying the QCDSME (Quality, Cost, Delivery, Safety, Morale, and Environment) strategy. In terms of Quality, there was a noticeable improvement in the performance of the excavator units. For Cost, there was a reduction in repair and maintenance expenses due to fewer breakdowns in the hydraulic and engine systems. In Delivery, the frequency of unscheduled breakdowns (BUS) decreased. Regarding Safety, critical work was minimized as a result of fewer breakdowns. Morale increased as the team's efforts and the results of their work became evident. Finally, for the Environment, oil spill waste was significantly reduced due to the elimination of hydraulic system leaks. This evaluation confirms the success of the repair strategies, leading to enhanced operational efficiency and positive impacts on safety, team morale, and environmental preservation.

Mining activities, particularly in the coal sector, contribute significantly to national economic growth. However, they also pose substantial challenges in terms of environmental protection and occupational health and safety (K3). One of the primary challenges faced is hydraulic oil leakage from excavators, which are key pieces of heavy equipment used in the mining process. This leakage leads to environmental contamination, which can harm the local ecosystem and pose health risks to workers in the vicinity of the mining area. Additionally, filter waste resulting from unscheduled filter replacements further exacerbates the negative environmental impact and increases the operational costs for mining companies (10) .

To minimize environmental impact and maintain workplace safety, a comprehensive effort is required that includes the implementation of modern technology, increased maintenance frequency, and the enforcement of strict safety procedures. One effective approach that can be adopted is the implementation of SMART safety—an action-focused strategy that is specific, measurable, achievable, relevant, and time-bound. This approach ensures a structured and efficient management of workplace safety and environmental protection, addressing key risks while improving operational performance (11). With these steps, the company can better monitor the condition of excavators and minimize the potential for oil leaks that could contaminate land and water. For instance, using sensor technology to automatically detect hydraulic leaks can significantly reduce the risk of large, undetected leaks that might otherwise go unnoticed until it's too late. This proactive approach enhances environmental protection and ensures timely interventions to prevent further damage.

Environmental protection efforts can also be strengthened by improving the filter waste management system. Unscheduled filter replacements are often necessary due to the use of B30 fuel, which technically shortens the lifespan of filters. By optimizing the filter replacement process and improving waste management, companies can reduce the environmental impact of filter waste and enhance operational efficiency. Regular monitoring and more sustainable waste disposal practices can further support these efforts (12). To reduce the amount of hazardous waste in the form of filters, effective waste management practices such as recycling and reusing used filters, as well as using fuel that is more compatible with heavy equipment, are crucial. These efforts not only minimize the risk of environmental pollution but also ensure that mining operations remain efficient and sustainable. Implementing these measures contributes to both environmental protection and the long-term operational efficiency of the mining industry.

In addition, protecting the health of workers must be a top priority. Oil leaks are not only hazardous to the environment but also pose significant risks to workers exposed to dangerous chemical substances. The process of handling leaks must be carried out in strict accordance with occupational health and safety (OHS) protocols, which include the use of appropriate personal protective equipment (PPE) and regular training for workers to prepare them for potential emergencies that may arise due to equipment failure. By prioritizing worker safety, the company can prevent accidents and ensure a safer working environment (13) . Comprehensive and strict regulations, along with practical policies, are crucial for enhancing safety and environmental protection in coal mining operations. Implementing policies that focus on environmental protection, health, and workplace safety can significantly reduce the risks associated with coal mining, including contamination from oil leaks and waste disposal. By prioritizing these efforts, the coal mining industry can create safer working conditions for employees while minimizing environmental impact. Additionally, the risk assessment process, including risk identification, analysis, and evaluation, is essential for effectively managing these challenges and improving overall mine safety (14) .

5. Conclusion

The implementation of the strategic repair plan at PT. AMM Site MHU has been successful and has shown optimal results. This is evident from the positive changes across all targeted elements for improvement (human/employee, machinery, and methods), which have generally resulted in a reduction of engine filter waste and environmental contamination due to oil leaks from excavators.The recommendations that can be provided after reviewing the results of the existing improvements include preparing and implementing the next repair plan for the relevant sections at PT. AMM Site MHU, with the goal of reducing the Redo Service percentage from 47% to 30% by December 2024.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Bappenas RI. 2021. "Indonesia and the World" 5 No.2 ;

[2] Buana, et al ., 2024. Implications of Environmental Law To Industry Bangka Mining . Journal Law Veranda , vol. 17. No. 2; 12-21;

[3] Amirudin A, Sukwika T, Ramli S, Burhanudin F, Saptaputra SK, Prianti IA. Level of safety performance achievement / safety maturity level in nickel mining: Study at PT. Putra Perkasa Abadi Jobsite MLP Southeast Sulawesi. World J Adv Res Rev. 2023;20(3):201–10.

[4] Amirudin A, Hidayanto I, Burhanudin F, Saptaputra SK. Implementation of safety management system in nickel mining: A Case of PT. Putra Perkasa Abadi Jobsite MLP in 2023. World J Adv Res Rev. 2024;21(02):324–334.

[5] Akhmaddhian, Suwari. 2017. Implementation Environmental Law Enforcement in the Mining Sector in the Regency Kuningan, February 4;

[6] Sugiyono. (2019). Methodology Study Quantitative and Qualitative And R&D. Bandung. ALFABETA;

[7] Directorate General of EBTKE. 2022. Performance Report of DIRECTORATE GENERAL OF EBTKE. Jakarta;

[8] Fatma, Ponda & Kuswara. 2023. Preventive Maintenance Analysis with the Method of Calculating Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) (Case Study of PT. Gajah Tunggal Tbk). Journal Heuristics, Vol. 17 No. 2; 87-94;

[9] Wahyudi. 2010. Development Wireless Network for Replacing Manual Download on Vehicle Health Monitoring System at PT. Sapta Indra Sejati. Jakarta.

[10] Marat, L., Rudakov., Konstantin, A., Kolvakh., Iana, V., Derkach. (2020). Assessment of Environmental and Occupational Safety in Mining Industry during Underground Coal Mining. Journal of Environmental Management and Tourism, doi: 10.14505//JEMT.V11.3(43).10

[11] Battalora, Linda. (2024). Technology Focus: Health, Safety, and Environment (August 2024). Journal of Petroleum Technology, doi: 10.2118/0824-0077-jpt

[12] Haryono, Ihwan., Muchammad, Taufiq, Suryantoro., Budi, Rochmanto., Ade, Kurniawan., Ahmad, Taufiqur, Rohman., Muhammad, Ma'ruf., Hari, Setiapraja., Taufik, Yuwono., Nur, Muhamad, Fuad., Eris, Riswandi. (2023). An Effective Three Level Filtration System for Improved Contaminant Removal in High Ratio Biodiesel Blends. Evergreen, doi: 10.5109/7151711

[13] Desai, Nikunjkumar. (2024). O-160 advancing occupational health and safety: employee led participatory action for chemical/dust exposure reduction projects. Occupational Medicine, doi : 10.1093/ occmed /kqae023.0876

[14] Chu, Chengcheng., Muradian, Natalie,. (2016). 1. Safety and environmental implications of coal mining. International Journal of Environment and Pollution, doi : 10.1504/IJEP.2016.10000739