EXAMINING THE ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY OF LUBRICANTS SUPPLY IN THE MINING INDUSTRY OF GHANA- A FOCUS ON EQUIPMENT RELIABILITY, PERFORMANCE, AND HEALTH CONSIDERATIONS

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ABSTRACT

The mining industry plays a significant role in Ghana's economic development. However, this sector's extraction and processing activities are often associated with substantial environmental challenges. One critical aspect of sustainable mining operations is the use of lubricants, which are essential for machinery and equipment reliability. This study aimed to examine the economic and environmental sustainability of lubricant supply in the mining industry of Ghana, with a focus on equipment reliability, performance, and health considerations post-use of conventional non-biodegradable oils. To achieve the study objectives, a triangulation mixed-methods approach combining qualitative and quantitative research methods was employed. A purposive non-probability sample technique, open-ended survey questionnaires were designed and distributed among thirty (30) experienced key stakeholders, including mining industry technical experts and environmental agency professionals. An extensive literature review was conducted on global standard best practices and regulations regarding spent oil management and embracing the circular economy in the mining industry as an environmental sustainability approach.

The quantitative phase focused on the economic sustainability, assessing mining companies with condition-monitoring and tribological (the study of friction, wear, and lubrication) reliability maintenance. A laboratory experiment was conducted to investigate the presence of heavy metals in spent oils and their effect on the environment.

The findings of this study show a 16.6% total annual lubricant cost saving for the mining companies on strategic condition-based reliability maintenance practices.

This strategic condition-based reliability maintenance practice improved mine machinery reliability and optimization performance indicators, such as Mean Time Between Failures

(MTBF), Planned Maintenance Percent (PMP), downtime percent, and Overall Equipment Effectiveness (OEE).

The lab experiment confirmed the presence of heavy metals in petroleum-based spent oils at unacceptable levels in reference to the WHO maximum permissible limits in water. The experimental results showed heavy metals such as Chromium (Cr), Copper (Cu), Lead (Pb), and Nickel (Ni) were present in spent oil with average concentration levels of 1.75ppm, 2.25ppm, 1.25ppm, and 1ppm, respectively for 20 samples of different grades of oils were all found to be higher than WHO maximum permissible limits (Cu-2ppm, Pb-0.01ppm, Cr-0.05ppm, Ni-0.07ppm of in water). The concentration of Chromium was also found to be higher than the WHO acceptable concentration of 1.6ppm in soil and for plants.

In the literature review, it was asserted that 33% of the energy required for moving vehicles is lost to friction. This is mainly due to poor lubrication, premature oil degradation due to heat, loss in oil viscosity, and contamination.

This means that to optimize lubricant use, there is a need to adopt strategies such as condition-based maintenance through oil analyses, oil dialyses, and improved offline and online filtration systems, which can increase oil life potency beyond often-recommended drain hour intervals by OEMs (0-250 hours and 250-500 hours on average for most equipment).

Statistics from research show that 53.3% of respondents confirm not being aware of sustainable lubricants. Hence, a recommendation to the above statistic is to propose Biodegradable or Bio-based lubricants as good substitutes for conventional petroleum-based lubricants because they are made from organic and renewable resources. These lubricants are environmentally sustainable and have no harm to the environment as they decompose naturally.

A recommendation is for government and mining regulators to revise the hazardous waste disposal procedure to adopt a circular economy model (recycling and reuse of spent oils), as well as increasing compliance. This will reduce the risk of heavy metals from reckless or accidental disposal of spent oil into the environment.

A recommendation is for all mining companies, not yet following condition-based reliability maintenance, to adopt this cost-saving model, as well as reduce mine machinery downtime due to the friction losses, and optimize energy use.

The study's outcomes serve as a basis for policy development, industry guidelines, and strategic decision-making aimed at promoting the circular economy and use of sustainable lubricants in the mining industry.