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Ljubiša Balanović
Dejan Tanikić

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

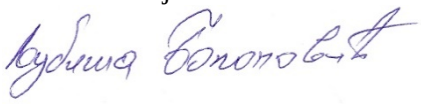
We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović



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RISK MANAGEMENT AND MINING MACHINES MAINTENANCE – A BRIEF REVIEW

Dejan Petrović, Jelena Ivaz, Saša Stojadinović, Predrag Stolić, Dragan Zlatanović

Technical Faculty Bor, University of Belgrade, V.J. 12, 19210 Bor, Serbia

Abstract

Establishing a risk-based maintenance policy creates a favorable atmosphere for creating a preventive maintenance model. This approach of machine failures enables the excavation process to take place without shutdowns. It is especially important in the case of machines with large capacities, because their failures results in large losses and delays in the production plan. It is crucial to thoroughly evaluate the severity of the consequences caused by the risk event, as well as their potential impact on the continuous operation of the technical system. The importance of the establishing of machine maintenance according to risk of failures is pointed out in this paper.

***Keywords**: risk, mining machinery failures, risk assessment, maintenance*

1. INTRODUCTION

The economic excavating of deposits with low metal content depends on implementing mass exploitation techniques, such as high-production and high-capacity excavation methods. For this type of production, large-capacity machines are necessary, e.g. trucks with a capacity of over 200 tons. Such machines have a high investment value and their improper maintenance can produce the negative economic influence of the company in whose production system they work. This is especially significant when considering the fact that they typically operate in tandem with other machines within the system.

In general, mining machines represent one of the most complex technical systems in the industry in general. They are distinguished by [1]:

- high investment value,
- they work in complex conditions and expensive technological processes and
- they present a high risk for the working and living environment.

After a certain period of operation of the machines from the time they were introduced into the production system, failures occur, i.e. they stop working. Failure in any form has a direct and detrimental impact on the success of a business. It hampers productivity, prevents meeting set targets, and causes delays in product delivery. Additionally, failure leads to the unfortunate loss of valuable customers. Also, it is very important to point out that machine failures also bring high financial loss to the company.

Apart from the impact on financial operations, failures of complex mining machines have a significant negative impact on the working and living environment. It often happens that workers are physically injured as a result of machine failure. Also, the leakage of hazardous and contaminating substances that reach water and soil additionally increase the severity of the consequences of mechanical system failure.

2. RISK MANAGEMENT

Quality and expert risk management provides a clear strategic approach to risk identification, control and reduction of the level of negative effects of a risky event. Such an approach creates the

conditions to prioritize and take appropriate measures in the appropriate part of the system, in order to reduce damage and financial losses. Risk management has other benefits for organizations, including safeguarding resources, assets, revenue and employees. Risk management and control in technical systems is a complex process and contains a large set of measures and activities. Risk management is a new discipline developed as a need to manage risks, not only in technological processes, but also in traffic, economy, financial sector, etc. A whole range of methods and procedures have been developed for risk assessment and management.

The risk management approach is characterized by four phases, [2]:

1. Risk identification – identifying hazards or situations that have the potential to cause damage or losses. Sometimes they are also called adverse events;
2. Risk analysis – analysis of the consequences that may arise from the risky event;
3. Risk management – deciding on appropriate measures to reduce and control unacceptable risk;
4. Implementation, control measurements of the projected risk level.

The most crucial stage of risk management is the identification of potential hazards. This involves pointing of wake points in the system and assessing the level of risk associated with the failure of specific components or the entire technical system. The measures that will be taken to reduce the risk of critical parts also depend on this.

The European standard on risk management ISO 31000 2009, provides principles and general guidelines on risk management. It refers to any type of risk, regardless of its nature, positive or negative consequences [3]. This standard was created as a result of experience in the field of risk management based on previously adopted standards in this area. ISO 31000 is based on the Australian-New Zealand standard AS/NZS 4360, 2004 [4]. The basis of this standard are clearly defined principles of risk management and the process of risk management. Also, the working framework of risk management is defined, which is given in the Figure 1:

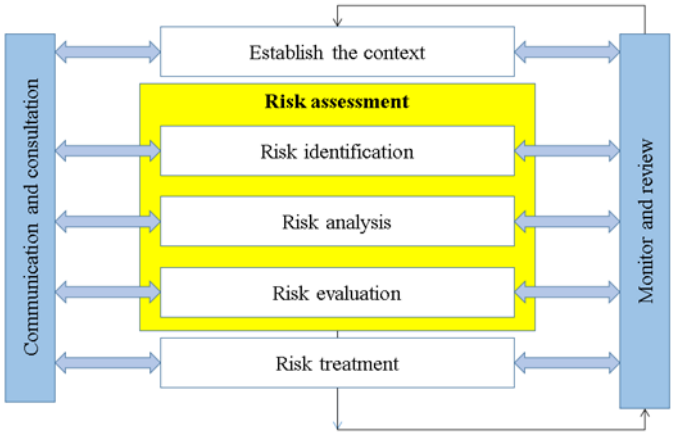

Figure 1 - Risk management according to ISO 31000

In general, the ISO 31000 standard does not define risk assessment methodologies, but the method and approach to this phenomenon. Techniques for risk assessment are given within the standard ISO 31010 2019, which explains the process of risk assessment and methods for risk assessment [5]. It provides guidelines for choosing the most appropriate method depending on the field where it is applied.

3. DEFINING MAINTENANCE POLICY - MAINTENANCE MANAGEMENT

Operation of mining machines without downtime requires extensive research, analysis and planning of high-quality systematic maintenance in order to provide machines functionality for a long period of time. When one element or part of the system stops working, it usually results in the interruption of the production process. It is known that, in the case of complex technical systems, despite a well-organized system for monitoring work and maintenance, certain elements fail, which can have negative consequences for the machine, employees and the environment. One of the basic requirements for mining machines is reliability in operation, i.e. as few unplanned downtimes as possible.

The maintenance system, i.e. maintenance management of complex technical systems in mining is a very important step in improving the business of a company. The introduction of a maintenance policy in mine systems means the introduction of a procedure for treating failures based on a predetermined procedure. Establishing a high-quality diagnostic system is crucial in this procedure as it allows for the identification of key indicators that signal failures. To ensure effective maintenance practices, it is crucial to develop a comprehensive failure database as part of the maintenance policy. This involves recording every occurrence of failure, allowing us to establish a clear timeline and relationship between severity of failure and operation and down time. By doing so, it can accurately determine the probability of future failures within a specific period. In order to maximize the operating time between two failures, the final stage of the maintenance procedure should include measures aimed at reducing the frequency of failures.

In general, for the reliable operation of machines in mining with the least possible risks, it is necessary to carry out:

- detailed analysis of the technical system using known methods, Figure 2,

- identify weak points,

- predict adverse impacts and their effects,

- define the measures that should be taken in order to keep the system in operational condition for as long as possible and perform the function for which it is intended, without negative consequences for the functional unit it forms as well as the working and living environment.

One example of a detailed decomposition of a technical system necessary for a detailed analysis is shown in Figure 2.

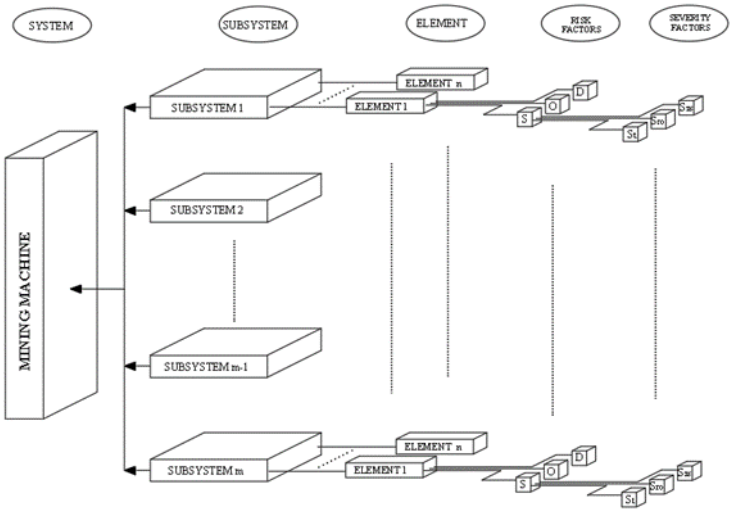

Figure 2 - Decomposition of the technical system [6]

The process of maintenance management is an essential step that must be integrated alongside all other activities within a company. For each activity a company is involved in, it is crucial to establish a comprehensive set of procedures aligned with the relevant industry standards. These procedures form an essential risk management algorithm.

In this sense, mining represents one of the most complex branches of industry considering the complexity of the technology and the machinery used, the costs of unplanned downtime and the working environment.

Constant monitoring and risk management are crucial in the mining industry due to the unique working conditions, the complex relationship between machines and the environment, and the potential impact of unexpected failures on both the machine's functionality and the entire technical system. The application and combination of existing and the development of new risk assessment methods and their implementation in mining technical systems create a favorable atmosphere for reducing of failure and creating maintenance management system.

4. CONCLUSION

Developing a comprehensive maintenance policy and effectively managing technical systems in the mining industry is crucial for minimizing maintenance costs and ensuring the smooth functioning of a company. Taking action on key points of failure prevention not only avoids production stoppages, but also prevents potential consequences and the need for additional financial resources.

The measures that should be taken in order to reduce the number of failures and the downtime of machines in mining are, first of all, a comprehensive analysis and risk assessment of failure and the reliability of the operation of mining machines and the reorganization of the maintenance system from inert to proactive maintenance according to risk in each of its forms. This approach to machine failures in mining will contribute to increasing the existing capacities of mining and mineral processing and reducing the costs of exploitation, processing and machine maintenance.

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