

INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH MANAGEMENT: PROTOCOLS FOR RISK REDUCTION IN THE MINING SECTOR

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ABSTRACT

The present research work consisted in knowing the industrial hygiene, health and safety protocols applied by the mining industries in the performance of activities to mitigate the risks to which workers are exposed. Thus, under this premise, the research problem was established, where the most important aspects of the risk factors: physical, chemical, biological and mechanical, which greatly affect workers in this important sector, are made known. The objective of the study was to know the protocols applied by the mining industry regarding the main hazard generating activities such as: exploration, transportation and drilling and the measures implemented for the mitigation of possible affectations. The results obtained show that the mining companies apply protocols in the performance of their activities, which helps to minimize the exposure of the mining worker to risk factors.

Key words: protocols, risk factors, exploration, transportation, drilling.

INTRODUCTION

Industrial hygiene and occupational health, according to (Pashanasi, 2020), mentions that: *“are taken as basic and indispensable tools to improve working conditions, such as the quality of life of all employees of an organization by minimizing occupational health risks”*.

According to, (Pashanasi, 2020), he mentions that: *“Industrial hygiene is the preventive discipline that studies the conditions of the working environment, identifying, evaluating and controlling contaminants of occupational origin, thus avoiding damage to health”*.

According to (Pashanasi, 2020), he mentions that: *“Occupational health allows developing and promoting the health of workers, preventing and controlling occupational diseases and accidents; thus eliminating risk factors and ensuring health and safety at work”*.

(Chunga P., 2021), mentions that: *“From each labor activity in general for their production they generate chemical, biological, physical or mechanical substances that when subjected to processes expel by-products that are harmful to human health and these residues also cause damage to the environment and in many cases are toxic to humans”*.

In this sense, we can point out that industrial hygiene and occupational health intervene to minimize risks inherent to the work activity and to promote health in the workplace, since an unsafe work environment is a potential risk to the health of workers, which maintained over time will produce work-related diseases and effects to the surrounding environment of the company.

(Chunga P., 2021), mentions that: *“The design and implementation of the process of occupational health and industrial hygiene, allows to increase the physical, mental and social health of the worker; promoting and developing the capacity of the collaborator, as well as his professional and social development. The prevention of occupational risks acts on the factors of the work environment in order to improve safety conditions and reduce accidents and occupational diseases”*.

Therefore, industrial hygiene and occupational health are present in labor activities, in the case of the mining sector this activity has been developed for many years; but, the concern for the health and safety of workers dates from recent times, according to (Gonzalez M., 2019), explains that: *“In the United States in 1969 legislation, regulations were established to protect the health of miners from respiratory diseases, especially Pneumoconiosis. This law is known as the Coal Act”*.

However, this premise was the first approach to protect the life and health of workers until today; however, there have been other supports in terms of international regulations for the protection of mine workers. According to, (Herbet H., 2010), he mentions that: *“In 1995 the ILO (International Labor Organization) Convention on Health and Safety in Mining was adopted, which has laid the groundwork for national action to improve working conditions in the mining industry”*.

In view of the problems found in mining operations, the research question is asked, are mining protocols complied with in the exploration, transportation and drilling processes in mining activities to mitigate the health affectations of workers? The objective of the documentary research

that we present under the title Industrial hygiene and occupational health management: protocols to reduce risks in the mining sector, through the bibliographic review, seeks to know the effectiveness of the application of safety and hygiene protocols that help to minimize health risks related to labor activities, and at the same time, to recommend improvements in the application of these protocols in the mining sector.

MATERIALS AND METHODS

In order to fulfill the objective of the research, to know the effectiveness of the application of safety and hygiene protocols that help minimize health risks related to work activities, and at the same time, to recommend improvements in their application in the mining sector, a bibliographic search of digital documents related to industrial hygiene and occupational health management programs where the assessment of risks in work activities is taken into account for the performance of each activity was carried out. The search is focused on Google Scholar, which is a database of electronic documents such as: journals, theses, brochures, offering publications in English and Spanish.

In order to collect digital information, we used search strings such as: *“protocols applied in mining”*, *“industrial and occupational safety in mines”*, *“working conditions in mines”*.

- A first search of primary sources yielded a total of 114 documents with the criterion *“protocols applied in mining”*.
- A second search with the criterion industrial and occupational safety in mines yielded 64 documents, which can be grouped into secondary sources.

Type of research

- According to its purpose and scope, the research is descriptive since it will observe characteristics and behaviors of the population, in this case to know which protocols are applied in mining for its activities in each stage of production.
- It is a non-experimental research since it will only observe real facts shown in figures in each research consulted.
- It is a qualitative research since it seeks to know through the experiences of the populations evaluated in the researches consulted and that help to know the application of the mining protocols.
- It is cross-sectional since it is grouped in an established time from 2016-2021 in electronic publications.

Research design

It allows the study of a problem with the purpose of broadening and deepening knowledge based on previous works, as well as information and data in digital format, hosted in different university repositories and international journals in Spanish.

The research developed has a non-experimental, cross-sectional and descriptive design.

- It is considered non-experimental because the variables will not be manipulated, they will only be analyzed in their natural state.
- The research is transversal-descriptive in that the study was directed to evaluate the effectiveness of the protocols used in the work activities of the mining sector and it is considered transversal since it is carried out according to the research collected in the years 2016-2021.

Population and sample

Population: The results in this type of documentation found are mostly given in relation to these countries of South America, since they are producers of minerals at industrial level, it is possible to obtain sources of own works of these countries. The population consists of 178 digital documents.

Sample: Composed of seven publications such as master's thesis being studies of publication in Spanish language, from the countries Peru and Ecuador.

• Search criteria

The digital documents found that are related to the research refer to international literature developed in South America and provide a guide for the research.

In the same, the publications of master thesis of students from public and private universities in South America were grouped. The evidence is evaluated for information related to the research topic regarding the application of safety and hygiene protocols at the mining sector level.

Table1. Search results based on the Google Scholar database.

Search engine	Type of information	Topic or subtopic	Main idea	Citation/ APA
Google Scholar	Digital repository thesis	Risk analysis in mining explorations to implement an occupational health and safety system in Peru.	The purpose of the research is to implement, manage and control an occupational health and safety system to obtain a culture of prevention for workers, guarantee their best working and health conditions and mainly minimize occupational risks in exploration activities.	Elias Giordano, C. y. (2016). San Ignacio de Loyola University Repository. Retrieved from http://repositorio.usil.edu.pe/handle/USIL/2427
Google Scholar	Digital repository thesis	Relationship between the level of preventive culture and compliance with occupational hygiene standards among workers in non-metallic mining companies.	The purpose of the research is to determine the relationship of preventive culture components such as commitment to the principles, level of knowledge and behaviors of workers with compliance with occupational hygiene standards.	Paucar Palomino, E. (2018). Universidad Nacional del Centro de Perú. Obtenido de http://repositorio.uncp.edu.pe/bitstream/handle/20.500.12894/5776/T010_10539539_D.pdf?sequence=1&isAllowed=y

Table1. Search results based on the Google Scholar database.				
Search engine	Type of information	Topic or subtopic	Main idea	Citation/ APA
Google Scholar	Digital repository thesis	Safety management in subway mining drilling and blasting operations: a systematic review from 2010-2019.	The collective objective of the research was a systematic review of a good implementation of a safety management system in drilling and blasting operations in subway mining, where articles were selected for the research.	Aranda Villalobos, P. J. (2020). Universidad privada del Norte. Obtenido de https://repositorio.upn.edu.pe/bitstream/handle/11537/25834/Trabajo%20de%20Investigaci%3%b3n_Total.pdf?sequence=21&isAllowed=y
Google Scholar	Digital repository thesis	Occupational health and safety management model applied to quarries in the Guayaquil canton.	This research was focused on the various factors that affect the integrity of workers in companies engaged in mining extraction. The objective is to design a safety and health management at work, aimed at improving the quality of the mining worker's work environment, creating spaces of well-being and safety in order to reduce or minimize risk factors.	Lama Moreno, G. E. (septiembre de 2019). Universidad de Guayaquil. Obtenido de http://repositorio.ug.edu.ec/bitstream/redug/44850/1/TESIS%20REVISION%20FINAL-LAMA.pdf

Table1. Search results based on the Google Scholar database.

Search engine	Type of information	Topic or subtopic	Main idea	Citation/ APA
Google Scholar	Digital repository thesis	Occupational health and safety management system to reduce occupational hazards at Troy S.A. mining company, Cajamarca	In this research work, the objective was to propose an occupational health and safety management system to reduce occupational risks, due to the lack of tools to minimize the risks of incidents and accidents.	Chunga Patiño, A. G. (2021). Universidad Nacional de Piura. Obtenido de https://repositorio.unp.edu.pe/bitstream/handle/20.500.12676/2542/IASIN-CHU-PAT-2021.pdf?sequence=1&isAllowed=y
Google Scholar	Digital repository thesis	Occupational health and safety management system to reduce occupational accidents at the Herrera Quarry.	The purpose of this research study was to propose an occupational health and safety management system to reduce occupational hazards. In this research the hazards are identified and the risks are evaluated to determine the controls to which the workers are exposed.	Tantalean Tenorio, J. E. (2020). Universidad César Vallejo. Obtenido de https://repositorio.ucv.edu.pe/handle/20.500.12692/49127

- Inclusion and exclusion criteria

In this documentary research study will be accepted as important information:

- Year of publication not less than 2016.
- Approved thesis of master's and specialist degrees in occupational health and safety.
- Works related to internal and external mining regulations.

Any article or thesis that does not accompany our research objective will be excluded from this research document, likewise those reports that are duplicated or do not have the author's permission.

RESULTS

In the search and selection of documents, key words were taken into account, eliminating information not related to the subject, reducing the result in seven electronic documents of the thesis type that are related to management systems, application of protocols in mining and labor conditions of workers.

Table 2. Selected articles per year

Year of publication	Quantity	Percentage
2016	1	14.28 %
2018	2	28.57 %
2019	1	14.28%
2020	2	28.57 %
2021	1	14.28%
Total	7	100.0%

It is worth mentioning that research from different years was found, but they were not taken into account because they were not related to the research topic.

Table 3. Selected articles by country

Country	Quantity	Percentage
Perú	6	85.71%
Ecuador	1	14.28%
Total	7	100.0%

The highest percentage of research found comes from Peru in repositories of universities

such as: National University of Piura, Private University of the North, Cesar Vallejo University, National University of Central Peru, among others.

Table 3. Electronic articles related to the application of protocols at the mining level

Number of articles related to protocols in the mining sector	Number of articles that refer to occupational health and safety	Quantity	Percentage
5		5	71.43%
	2	2	28.57%
Total		7	100.0%

In the table it can be seen that the documents found in the search carried out, five of these electronic documents refer to protocols in the mining sector. Therefore, it is important for the research to obtain this data to support the objective of the study. The validity and reliability of documentary research allow the information consulted in primary sources to provide data that, when mentioned in the research, serve as a reference for further work.

Data extraction

In order to carry out the documentary research, it was verified in the methodology of each research consulted whether they had a level of reliability and validity of the data, through the use of techniques and instruments used in the collection of information.

We can mention that:

- The research found in the repository of the San Ignacio de Loyola University and the National University of Peru, are used as techniques and instruments for collecting information: a questionnaire to collect field data information. These researches were conducted in the years of 2016 and 2018.
- The research found in the repository of the Universidad del Norte, is a systematic review given in the years 2010-2019 so they use techniques such as documentary review of 20 articles, in which they use collection techniques such as databases, repositories of national universities among others.
- In the research presented by the Cesar Vallejo University and the National University of Piura in the years 2020 and 2021 respectively, they use as instruments of validity and reliability of the information: documentary research, data collection in the field, so they are considered as types of mixed research since it is a study that supports qualitative research in its first phase and then in a quantitative research since it presents data that are

measurable to obtain results.

Table 4. Results obtained regarding the application of protocols in the mining sector.

Articles consulted related to protocols in the mining sector and occupational health and safety	Quantity	Percentage
Protocols to avoid physical and mechanical hazards. <ul style="list-style-type: none"> • Provide and ensure the use of hearing protection. • Proper maintenance of vehicles, machinery and tools. • Perform audiometric tests to personnel. • Control exposure time. 	2	28.57%
Protocols to minimize biological, chemical and physical risks. <ul style="list-style-type: none"> • Provide and ensure the use of personal protective equipment (helmet, safety glasses, gloves, safety shoes). 	3	42.86%
Protocols for minimizing exposure to ergonomic risks <ul style="list-style-type: none"> • Have work days with planned breaks. • When performing activities in narrow spaces, have spaces for posture rest. 	2	28.57%
Total	7	100.0%

It is possible to observe the percentage obtained on the articles consulted to verify the percentages of protocols applied in the mining sector in the activities carried out. It is worth mentioning that the bibliographies consulted for the research found protocols applied in terms of hygiene, health and safety of workers in mining. Regarding hygiene and health, a percentage of 42.86% of protocols to minimize noise, dust and particle emissions in the performance of tasks, which affect the worker's health, were found. The information supporting this project was extracted from these documents. Safety is also given importance in terms of the application of procedures to minimize mechanical risks with a percentage of 28.57%.

According to the results obtained from the research it is observed that the protocols are applied in mining in relation to the work processes: exploration, transport and drilling, so the necessary measures are taken to mitigate the risks to which workers are exposed.

DISCUSSION

The objective of this research was to know the protocols or procedures applied in the mining sector to minimize exposure to physical, ergonomic, chemical, biological and mechanical risks that threaten the health and safety of workers. The results obtained from the literature review show

that prevention measures are applied in the mining sector to help minimize exposure to these risks.

The search was carried out in the period 2016-2021, finding a sample of 178 electronic documents of which when applying the inclusion and exclusion criteria, 7 documents were used. In Latin America, in countries such as Peru, Colombia and Ecuador, the safety and health of mining workers has been gaining importance, as there are procedures applied to minimize risk factors, providing a safe environment, avoiding loss of human lives and products, thus generating value and differentiation for the business.

The risk factors to which mining workers are exposed depend on the time of exposure and the task they perform; however, in the bibliographic review consulted, the documents focused on physical, chemical, biological and mechanical risks. And in the protocols that are applied in the performance of tasks in the mining sector. The results obtained from the review show a high percentage of application of procedures to minimize exposure to physical, biological and chemical risks.

The bibliography consulted focuses on research works that seek to know factors that affect the integrity of workers, reduce accident levels through the implementation of an occupational health and safety management system and the application of safe work procedures.

However, from the point of view of occupational safety and health, it is necessary to implement measures regarding exposure to noise, vibrations, particles and polluting gases, ensuring the safety and health of workers.

CONCLUSIONS

1. What was observed in the bibliographic review was with the purpose of knowing the protocols applied in the work of the mining industry where they are exposed to physical, chemical, biological, mechanical and ergonomic risk factors. Updated and truthful documentary information was collected to provide the risk factors and thus the protocols applied to minimize the effects on the health of workers.
2. This is how it was identified through the researches consulted the risk factors in the drilling, exploration and transportation processes, which are the processes that mostly affect the workers, the preventive measures that are applied to mitigate the affectations.
3. This project allowed to carry out a research work based on the review of digital documents to know the problem, taking into account the experience of the authors that support the data obtained.

BIBLIOGRAPHIC REFERENCES

- Aranda Villalobos, P. J. (2020). Universidad privada del Norte. Obtenido de https://repositorio.upn.edu.pe/bitstream/handle/11537/25834/Trabajo%20de%20Investigaci%3%b3n_Total.pdf?sequence=21&isAllowed=y
- Bonilla Rueda, L. R. (2014). UNICIENCIABGA. Obtenido de <https://www.unicienciabga.edu.co/images/documentos/investigacion/boletines/Prevencion-riesgos-laborales.pdf>
- Calcin Quesquezana, A. M. (2018). Universidad nacional de San Agustín de Arequipa. Obtenido de <http://repositorio.unsa.edu.pe/handle/UNSA/7302>
- Chunga P., A. G. (2021). Sistema de gestión de seguridad y salud en el trabajo. Obtenido de <https://repositorio.unp.edu.pe/bitstream/handle/20.500.12676/2542/IASIN-CHU-PAT-2021.pdf?sequence=1&isAllowed=y>
- Chunga Patiño, A. G. (2021). Universidad Nacional de Piura. Obtenido de <https://repositorio.unp.edu.pe/bitstream/handle/20.500.12676/2542/IASIN-CHU-PAT-2021.pdf?sequence=1&isAllowed=y>
- Díaz Orozco, O. M. (2012). Dialnet unirioja. Obtenido de https://dialnet.unirioja.es/buscar/documentos?querysDismax.DOCUMENTAL_TODO=+trastornos+musculo+esqueleticos+en+conductores+
- Elias Giordano, C. y. (2016). Repositorio de la Universidad San Ignacio de Loyola. Obtenido de <http://repositorio.usil.edu.pe/handle/USIL/2427>
- Gonzalez M., O. U. (2019). Condiciones de seguridad y salud en el trabajo, una revisión teórica desde la minería colombiana. Redalyc, 1. Obtenido de <https://www.redalyc.org/jatsRepo/290/29058864013/html/index.html>
- Herbet H., J. y. (2010). seguridad y prevención en minas. Obtenido de http://oa.upm.es/10673/1/080509_L2_SEGURIDAD_Y_SALUD_EN_MINERIA.pdf
- Huachaca S., M. y. (marzo de 2019). Repositorio Universidad de Perú. Obtenido de https://repositorio.utp.edu.pe/bitstream/handle/20.500.12867/1792/Marelyn%20Salinas_Michael%20Vera_Tesis_Titulo%20Profesional_2019.pdf?sequence=1&isAllowed=y
- Lama Moreno, G. E. (septiembre de 2019). Universidad de Guayaquil. Obtenido de <http://repositorio.ug.edu.ec/bitstream/redug/44850/1/TESIS%20REVISION%20FINAL-LAMA.pdf>
- Ledezma, R. D. (agosto de 2019). Scielo. Obtenido de <https://scielo.conicyt.cl/pdf/cyt/v19n59/0718-2449-cyt-19-59-00113.pdf>
- Mallma Acuña, A. y. (2014). Revista Enfermería Herediana. Obtenido de <https://revistas.upch.edu.pe/index.php/RENH/article/view/1799>
- Pashanasi, J. A. (2020). Seguridad y salud ocupacional para reducir los riesgos Obtenido de <https://repositorio.upn.edu.pe/bitstream/handle/11537/27016/>

Amasifen%20Pashanasi%20Janali%20-%20Campos%20Mamani%20Luis%20Javier.
pdf?sequence=1&isAllowed=y

- Paucar Palomino, E. (2018). Universidad Nacional del Centro de Perú. Obtenido de http://repositorio.uncp.edu.pe/bitstream/handle/20.500.12894/5776/T010_10539539_D.pdf?sequence=1&isAllowed=y
- Rubio Valencia, N.I. (2019). Universidad del Rosario. Obtenido de <https://repository.urosario.edu.co/bitstream/handle/10336/20634/RUBIOVALENCIA-NATALIAINES%20Y%20PE%c3%91ARANDA-KARINA.pdf?sequence=1&isAllowed=y>
- Tantalean Tenorio, J. E. (2020). Universidad César Vallejo. Obtenido de <https://repositorio.ucv.edu.pe/handle/20.500.12692/49127>