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ABSTRACT

Abstract: Big Data applied to mining, contemplates the combination of algorithms located in advanced technological tools to process a quantity of data, Power BI allows the interaction of different data formats, for integration it has the support of Python Script. In this article, Big Data was applied to essential activities such as drilling and blasting, analyzing the parameters, standards, quantities, advances, the objective was to develop an integration system of a quantity of data for its analysis and interpretation, it will contribute to decision making in the mining operation. The development of Dashboard for interactive reportability based on indicators, will allow to visualize more efficiently and in a virtual way among the interested parties. Finally, the application of Big Data in the field of mining mainly in the treatment of its data will be the trend of the future which will allow to optimize the time and the functionality of the reports.

CCS CONCEPTS

• **Information systems** → data management systems; database administration; database utilities and tools; • **Human-centered computing** → visualization; visualization systems and tools..

KEYWORDS

Dashboard, Power BI, mining companies, drilling, blasting

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1 INTRODUCTION

Mining companies continually seek to implement the latest, most reliable and cost-effective technological automation [1], to keep high productivity and safety in their operations. These technologies must be applied in drilling and blasting, because of their greater economic investment, the objective of drilling is to make a hole in the surface to be charged with explosives. The blast has the main objective of fragmenting the rock using large amounts of explosives [2]. In drilling and blasting, technical parameters such as burden, spacing, depth, diameter of the drilling hole, explosive mass, rock resistance are considered to get the desired granulometry [3]. The se technical parameters generate a great amount of data.

Big Data allows the company to carry out a more complete analysis of data that is not supported by conventional software, contributes to decision-making in the face of problems and / or raises improvements with the analysis, reducing uncertainty [4]. The collection of data, processing, exploration, analysis and presentation of unstructured and semi-structured data will become the priority of Big Data innovation and traditional structured data will no longer be the core of Big Data [5]. When the organization performs a Big Data process, it faces various challenges and these have given rise to many risks to make a decision [6].

In addition, Big Data searches for the requested information, discovers relationships or hidden patterns in a data set, which must be treated with variety, volume, speed, privacy, precision, trust and instruction [7]; to generate this information a massive set of data is required, these can be numerical, figures and text documents, or more complex information such as spatial data, multimedia data and hypertext documents [8].

With the large amount of data, it was urgent to use techniques, methods and theories that can process huge volumes of data and obtain useful information from them. In this article, the authors

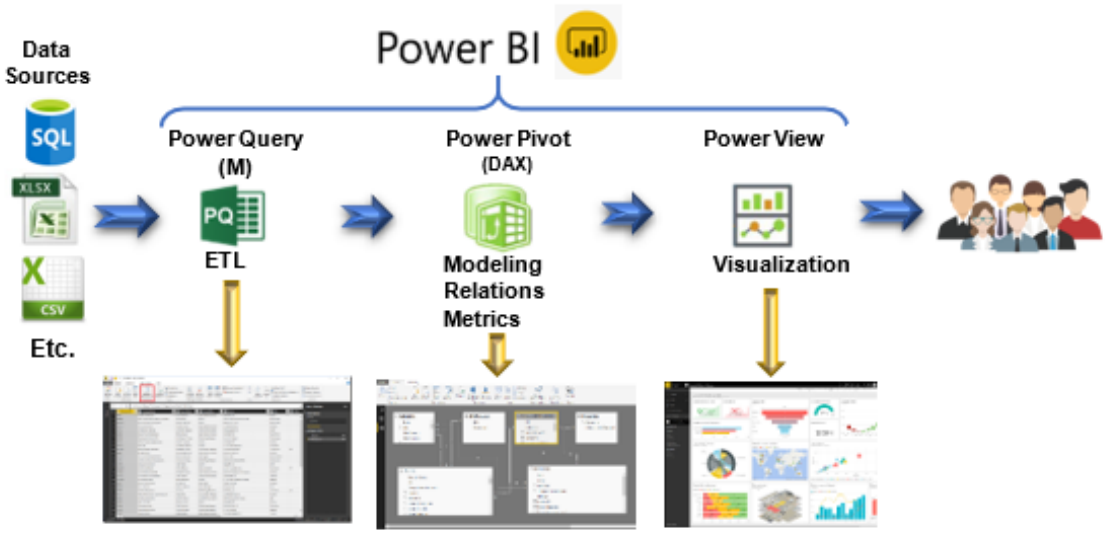

Figure 1: Relationship between Power BI and Excel add-ins

Table 1: Technical parameters of the copper mine

Parameter	Quantity
Rock mass density (S.G)	2.5
Average uniaxial compressive strength (MPa)	140
Mineral reserves (million tons)	6.4
Copper grade (%)	0.70
Clearing ratio	1/0.60
Average drilling speed (m / h)	50
Drill Diameter (Production and Damped)	$12\ ^{1}/_{4}$”
Drill diameter (pre cut)	5”
Bench height (m)	15
Operation cost (US $ / Tn)	2.6

created a detailed, interactive and easily accessible results report, using Power BI software that will help in decision-making and improvement proposals using Big Data in the drilling and blasting processes of the mining company.

2 MATERIALS AND METHODS

Big Data was used in the data capture, storage and processing of the copper mining company in the Central Andes. This company had a large amount of information in the drilling and blasting processes that were not processed properly, causing economic losses and inefficiency in control. In this article, we work with data in Excel-compatible formats because end-users are familiar with it. Therefore, we decided to use Excel and Power BI for the analysis and presentation of the results through the dashboards.

Power BI is a new way of working with data. It is a very powerful analysis tool that allows data integration in an accessible way. This software transforms data into reports that can be easily shared on any device. Compile single-view multi-panel displays for rapid decision-making and data integration [9]. This software is free, it can be downloaded from Microsoft's websites. Power BI has a set of features that replace Excel's Power Query, Power Pivot, and Power View add-ins, which together turn data into compact, interactive information (Figure 1).

3 POWER BI APPLICATION IN DATA ANALYSIS

We work with information from an open pit copper mining company located in the Central Andes. This mine works 24 days a month, during which drilling and blasting operations are carried out. Therefore, the time scale is established with these operational days. Some of the technical parameters of this mine are mentioned in (Table 1).

In this chapter we will describe how we apply Power BI on the large amount of company data (Figure 2). So we had to clean and

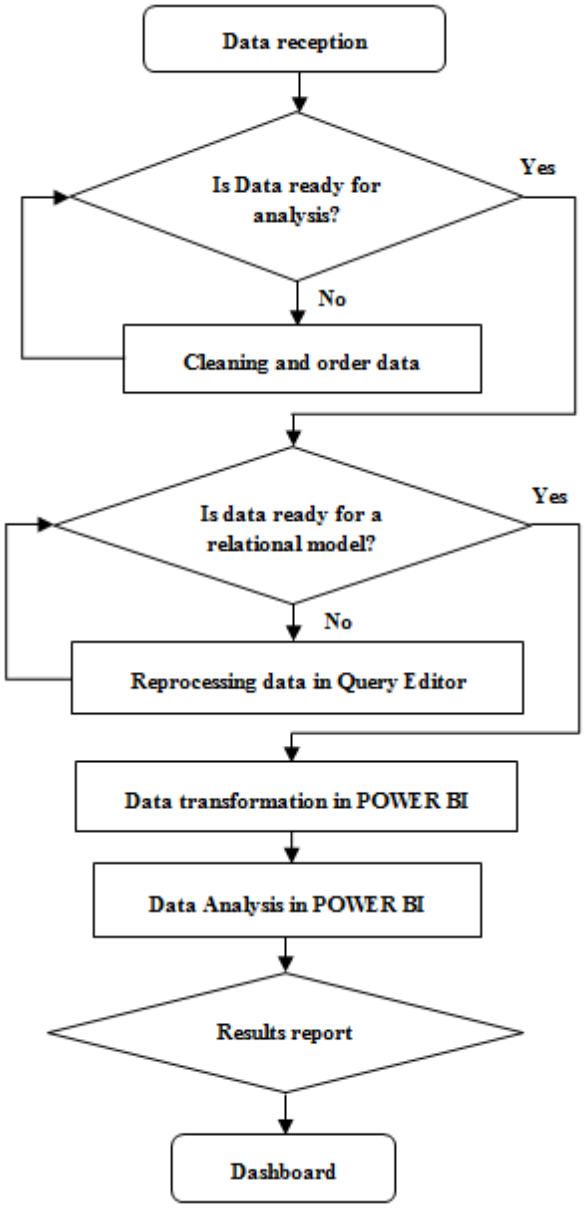

Figure 2: Big Data analysis flowchart in Power BI

prepare that data. Our data comes from the operations department of the mining company. The methodology of analysis of technical and economic data is investigated using Big Data analysis technologies [10].

3.1 Receiving data

The raw data collected from the recorded database from drilling and blasting activities was not suitable for data analysis. They contained problems in the naming of the data, the relationships were not defined between them, confusion due to the lack of hierarchies. The data were exported from the database and stored in Excel formats such as *.csv and *.xlsx.

Data from the mining company was used to prepare the Vibration Record, Drilling Report with Water, Drilling Report and Blasting Report.

The vibration recording was performed using data obtained from the SSR-OMNI model radars, designed to detect areas at risk of movement with an ultra-fast scan, the equipment's intelligent processing algorithms reduce the size of the raw data by 96.5%, ensuring that the file size is as small as possible [11]. The data on drills with the presence of water in the project were compiled with technical sheets by the blasting supervision area through the measurement and review of each drill drilled to corroborate the established height, diameter and water content. The drilling report data was taken by the equipment operators during each shift, considering the types of drill and project. The blasting report data were taken with technical sheets by those in charge of the blasting process, taking into account the mesh design, geology, granulometry to be obtained, location, among others; This file after the blasting process has to be checked with the powder magazine (explosives store).

3.2 Cleanliness and order of data

Before we started working with the data, we first had to examine it. This step was important because we needed to find out if the data is suitable for analysis. We study the consistency of the data, look for hierarchies, and examine the values of the data. The data we worked on had a lot of issues like duplicate records, missing details, and inconsistent data. They were also saved in Excel tables and in separate folders. In each table, the data was separated by date. It meant cleaning, transforming and merging operations on a single report of approximately 50,000 pieces of data.

3.3 Data pre-processing

We used the Power BI Query Editor tool (Figure 3) for data preprocessing. To obtain the appropriate data for analysis we work with queries. Little by little we were configuring queries to eliminate each identified problem. The new tables contain all the data, without the problems previously detected. Furthermore, the tables created are suitable for analysis, according to the defined requirements. Being suitable for viewing through dashboards.

3.4 Data transformation

The result of the Query Editor is a unified table that is processed in the modeling tool in Power BI. Our goal was to create an information system capable of responding to different queries. Therefore, it was necessary to modify the unified table. The table is modified according to the requirements of relational data sources.

This data model allows us to start with data analysis. The tables and the connections between them were designed with the help of the mining company staff. This data model is general and can be used to create optional analyzes.

Table 2: Reports created with the data received

Criterion	Parameters	Type
Vibration Report	Date	Qualitative
	Distance (m)	Quantitative
	Transmitted speed (mm / s)	Quantitative
	Vertical speed (mm / s)	Quantitative
	Radial speed (mm / s)	Quantitative
	Frequency by type of explosive (Hz)	Quantitative
	Peak particle velocity (mm / s)	Quantitative
Water Drill Report	Date	Quantitative
	Drill type	Qualitative
	Ordered height (m)	Quantitative
	Real height (m)	Quantitative
	Amount of water (m3)	Quantitative
	Mix type	Qualitative
	Amount of explosive (Kg)	Quantitative
Drilling report	Date	Quantitative
	Drilled meters (m)	Quantitative
	Pulldown sensor (KN)	Quantitative
	Sensor torque (KN-m)	Quantitative
	Rock type	Quantitative
	Drilling speed (m / h)	Quantitative
	Drill depth (m)	Quantitative
Blast report	Burden (and)	Quantitative
	Spacing (m)	Quantitative
	Tonnage (Tn)	Quantitative
	Density (gr / cm3)	Qualitative

3.5 Data analysis

To calculate the values required to perform the analysis, the DAX formula language is required. It is a library of functions and operators that can be combined to create formulas and expressions in Microsoft SQL Server, Power Pivot in Excel, and Power BI Desktop.

Our first data analysis focused on the record of vibrations in the blast of the company for months. To do this we evaluate the vertical, radial and transmitted speeds, and the frequency of vibrations by type of explosive. The result was the identification of values within limits, values at the edge and values outside of acceptance for the safety of workers, machinery and the environment. In the second analysis we focus on the evaluation of the presence of water in the drills and its influence on the amount of explosive used. Identifying the maximum allowable water presence limit for the adequate development of the mining project.

The third analysis focused on the preparation of a drilling report, through the control of the burden data, spacing, drilling speed and the advance in meters drilled. The variation of the mathematical values calculated in the drilling as overdrilling, increased burden or spacing, influence the efficient development of this activity and increase the costs of the mining company's operations area. The last analysis considered the preparation of a blast report. For this, the results in tons of ore extracted by type of explosive were evaluated. Determining the optimal explosive values to obtain the highest efficiency.

3.6 Report of results

When we created the analyzes, we were considering actual reports from a copper mining company. We did this because our results could be compared with the data analysis traditionally used in the company. The analyzes are carried out through visualization techniques of processed data such as the Dashboards created in Power BI and then analyzed by pivot tables. Dashboards are used in the field of business intelligence and Big Data because they contain detailed, interactive and easily accessible information, which is of utmost importance, making analysis possible quickly and easily, where you can display bars to choose. and access highly useful information.

4 RESULTS

Each figure illustrates information about the drilling and blasting activities of the copper mining company. These charts are interactively connected and in case of choosing a parameter in a chart, all charts automatically recalculate the values. For the proper use of the information system, knowledge of Excel and Power BI is necessary to work with the Big Data of the company.

In figure 3, (a): Represents the Vibration Report created by Power BI, the range of dates where the record was made is observed, in this we can see the day, month and year; also the level of the pit, in addition you can see important data such as the project record that shows the project, number of holes, drilled distance and radial frequency; in turn, vertical, transmitted and radial speed meters

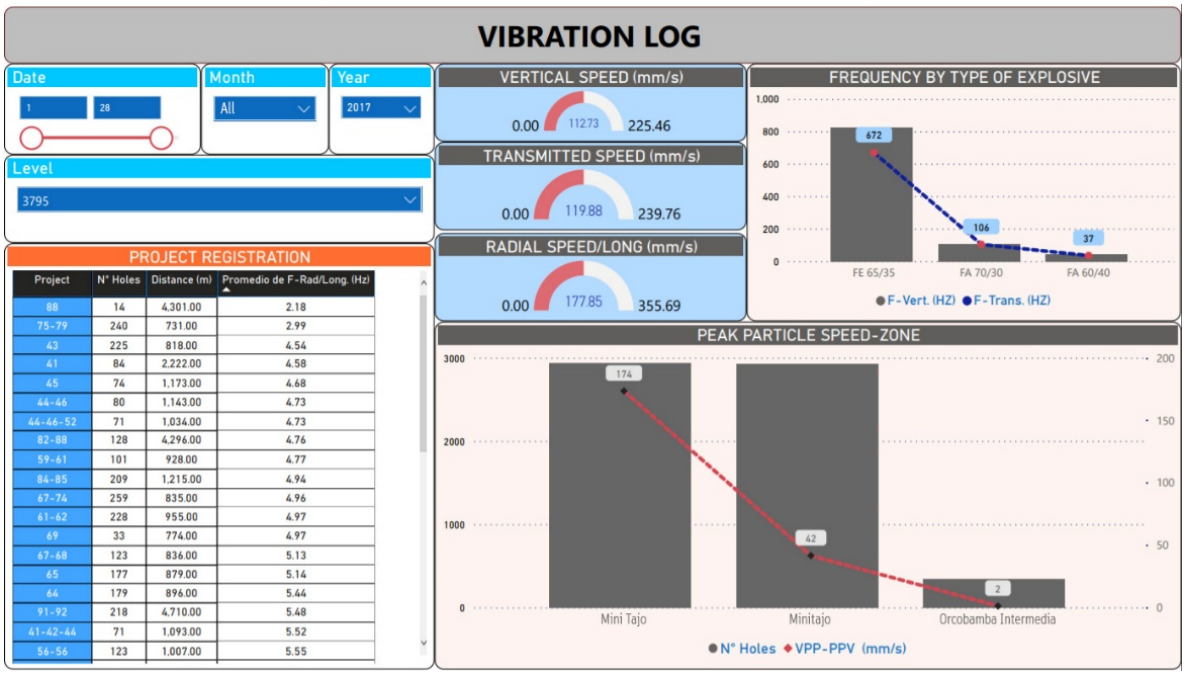

Figure 3: (a). Vibration report created in Power BI / (b). Water hole report created in Power BI.

are shown; Likewise, it shows bar graphs of frequency by type of explosive and peak particle velocity by zone.

In figure 3, (b): Represents the Drills with Water Report created by Power BI, the range of dates where the registration was made is observed, in this we can see the day, month and year; also the level of the pit; also a table of kilos of explosives per operator, a graph of drill bars by zone, final plug by type of drill, relation of real and requested heights per project, average of water content per project and finally a table of the relation of blasting type with explosive mixture.

In figure 4, (a): Representing the Drilling Report created by Power BI, the range of dates where the record was made is observed, in

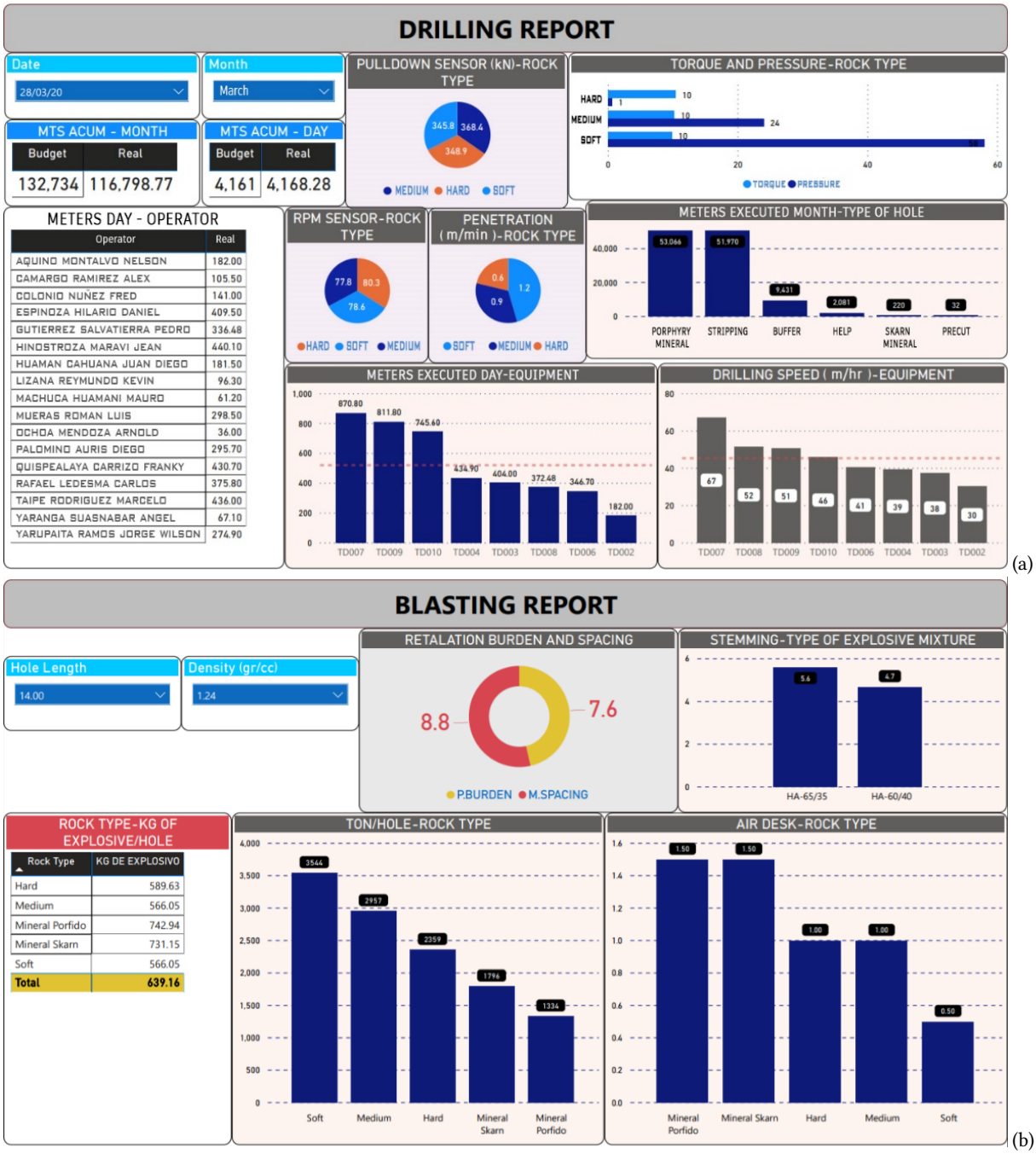

Figure 4: (a): Drill report created in Power BI / (b): Blast report created in Power BI

this we can see the day, month and year; also the level of the pit, also tables of accumulated meters per day and year are shown; at the same time, the meters drilled per day for each operator, also shows graphs of torque and pressure bars by type of rock, meters executed per month by type of drill, meters executed per day by each equipment and drilling speed by each equipment and finally graphs of Pulldown cake, RPM sensor, penetration speed by rock type are shown.

In figure 4, (b): Represents the Blast Report created by Power BI, the drilling depth and rock density are observed, as well as a table of rock type and amount of explosive used, also a Burden relationship pie chart is shown. and Spacing. Finally, the dowel bar

graphs are shown by type of explosive mixture, ratio of tons of drill - by type of rock and air pockets by type of rock.

5 DISCUSSION

Now a days, the copper mining industry is increasing in Peru and the need for handling Big Data has increased monumentally. The companies apply new methodologies and furthermore improve the approaches in analyzing Big Data [12]. In this study, we can notice that drilling and blasting processes in a mine, generates great amounts of data.

In order to manage such information, the Microsoft Power BI was chosen, because it demonstrates to the organization enormous potential by expanding access to business intelligence and supporting a culture of data-driven decision making. Engineers benefit from fast deployment, a secure, hybrid configuration, and easy integration with existing information technology systems. In addition, they can view and analyze all of their data in one place with live dashboards and reports [13].

According to our experience, Power BI has shown that it is a radical approach to simplifying the management intelligence and data analytics space, whereby individuals processes can easily provide data, build reports or have them automatically created, aggregate them in dashboards, and share it with minimal investment of time and effort. It is evident that Power BI is a unique opportunity for research institutions and professionals to fulfil their data analysis needs [14]. Through this research, it was clarified that visualization of data is a very important thing in every organization and Business development, by means of visualization the end user or user can read the data easier and convenient to understand the data [15].

In general, Power BI could be considered as the most viable solution to the problem of inadequate data processing of the drilling and blasting processes of the copper mining company, because it offers the adequate visualization of the information and interaction with the user, that will allow us to identify the existing problems in the company.

6 CONCLUSIONS

In recent years, the digital age has been applied in all industries, especially in mining as it is an activity that involves a high investment. That is why mining companies choose to study new technologies that help to optimize their processes by reducing work time and achieving new objectives.

Big data analysis applied to activities such as drilling and blasting is essential for the mining company. With the interaction of technical parameters presented in the dashboards, mining companies have the opportunity to see the relationship of parameters, at the same time see progress, performance, etc. The set of these representations will make companies very clear about their strengths and weaknesses, looking for opportunities for improvement that points to a single objective that is to reduce costs with maximum productivity.

Power BI is a tool that allows the integration and interaction of different data formats such as csv, xlxs and others, it is supported by Python Script to generate complex equations. In this article, the Power BI software was used to analyze the Big Data of the drilling and blasting processes in a copper mine in the Central Andes in search of optimizing the control of the project through interactive, virtual and easily accessible Dashboards thanks to to digitization.

Our results show that this software is capable of creating complex data analysis that meets the needs of the administrative area of the mining company that provided us with the data. We consider Power BI as the most viable solution to analyze the Big Data of companies of all commercial areas.

REFERENCES

[1] R. Singh and Arvind K. Mishra. 2016. Review of IT enabled technologies in Indian mining industry for improved productivity & safety, 3rd International Conference on Recent Advances in Information Technology, RAIT 2016, 613–618, https://doi.org/10.1109/RAIT.2016.7507969.

[2] A. Shehu, M. A. Jethro, D. A. Ogbodo, and M. H. M. Hashim. 2019. Correlation of blasting coefficient with drilling rate of rocks, Materials Today: Proceedings, 17: 543–552, https://doi.org/10.1016/j.matpr.2019.06.333.

[3] Abbaspour, C. Drebenstedt, M. Badroddin, and A. Maghaminik. 2018. Optimized design of drilling and blasting operations in open pit mines under technical and economic uncertainties by system dynamic modelling, International Journal of Mining Science Technology, 28 (6): 839–848, https://doi.org/10.1016/j.ijmst.2018.06.009.

[4] Espinosa, Larisa Garriga, Jose Jacobo Zubcoff, and Jose Norberto Mazon. 2015. Linked open data mining for democratization of Big Data, 2014 IEEE International Conference on Big Data, IEEE Big Data 2014, 17–19, https://doi.org/10.1109/BigData.2014.7004479.

[5] Xianglan. 2017. Digital construction of coal mine Big Data for different platforms based on life cycle, 2017 IEEE 2nd International Conference on Big Data Analysis, ICBDA 2017, 456–459, https://doi.org/10.1109/ICBDA.2017.8078862.

[6] Kumar Pandey and Diwakar Shukla. 2018. Challenges of Big Data to Big Data mining with their processing framework, 8th Int. Conf. Commun. Syst. Netw. Technol. CSNT 2018, 89–94, https://doi.org/10.1109/CSNT.2018.8820282.

[7] Che, Mejdl Safran, and Zhiyong Peng. 2013. From Big Data to Big Data mining: Challenges, issues, and opportunities, Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics), 1–15, https://doi.org/10.1007/978-3-642-40270-8_1.

[8] K. Deepa, J. Rexy and R. Geetha. 2013. Rapid development of applications in data mining, Proceedings of 2013 International Conference Green High Performance Computing. ICGHPC 2013, 1–4, https://doi.org/10.1109/ICGHPC.2013.6533916.

[9] Y. Wright and Bianca Wernecke. 2020. Using Microsoft©Power BI©to visualise Rustenburg Local Municipality's Air Quality Data, Clean Air J., 30 (1): 1–5, https://doi.org/10.17159/caj/2020/30/1.7512.

[10] Ming, Lingling Zhang, Jinhai Sun, and Yi Zhang. 2018. Analysis models of technical and economic data of mining enterprises based on Big Data analysis, 2018 the 3rd IEEE International Conference of Cloud Computing Big Data Analysis. ICCCBDA 2018, 224–227, https://doi.org/10.1109/ICCCBDA.2018.8386516.

[11] 2020. SSR-OMNI. Retrieved Aug. 20, 2020 from https://www.groundprobe.com/product/ssr-omni/?lang=es&fbclid=IwAR1M5bRKUNTwX9tUIMCCdZwCUZHi7wwObGD4nHUI8PKQIM50Tv8iZ_qWV8w

[12] Shukla, V. Kukade, and S. Mujawar. 2015. Big Data: Concept, Handling and Challenges: An Overview, International Journal of Computer Applications, 114(11): 6–9.

[13] Amrapali and A. K. Upadhyay. 2017. Microsoft Power BI, International Journal of Soft Computing and Engineering, 7 (3):1–94.

[14] Krishnan, S. Bharanidharan, and G. Krishnamoorthy. 2017. "Research Data Analysis with Power BI", 11a Convention on Automation of Libraries in Education and Research Institutios (CALIBER), page 8.

[15] Geetha Bhrargava, Tara Phani Surya Kiran, and Duvvada Rajeswara Rao. 2018. Analysis and Design of Visualization of Educational Institution Database using Power BI Tool, Global Journals of Computer Science and Tecnology, 18 (4): 9.