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Data digitalisation in the mining industry – a scoping review protocol

J. Duarte[a], Fernanda Rodrigues[b], J. Santos Baptista[c]

[a]Associated Laboratory for Energy, Transports and Aeronautics (PROA/LAETA), Faculty of Engineering, University of Porto, PT (jasduarte@fe.up.pt) ORCID: 0000-0002-5856-5317. [b]RISCO, ANQIP, University of Aveiro, Aveiro, PT (mfrodrigues@ua.pt) ORCID: 0000-0001-9127-7766. [c]Associated Laboratory for Energy, Transports and Aeronautics (PROA/LAETA), Faculty of Engineering, University of Porto, PT (jsbap@fe.up.pt) ORCID: 0000-0002-8524-5503

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Abstract

The new trends in technology, allied to the industrial revolution has been creating opportunities for developments in almost every industrial field, which includes the mining industry. Mining 4.0 is a recent conception, trying to achieve optimal production control through digital and technological innovations. However, it is of fundamental importance to know what are the existent methodologies for data digitalisation, as well as the data that is actually been used. In order to do so, the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews was used to write a guideline for conducting a scoping review on the subject. All information regarding the review are explained: screened sources, research methodologies, used keywords, exclusion and eligibility criteria, amongst others. The methodologies to handle the collected information is also clarified, as well as the research team's instruments.

1. INTRODUCTION

The past few years have witnessed the emergence of the fourth industrial revolution, known as Industry 4.0. This broad term includes the shift from the traditional manufacturing companies to smart factories environment, relying both on automation and digitalisation conceptions towards the excellence in operation (Hermann, Pentek, & Otto, 2016; Setiawan & Yahya, 2018). The link between the real (physical) world and the virtual (digital) world is provided by the informatisation of data in several fields (Zelko & Spišák, 2013), and technological development is seen as a central factor which leads to the increase of the growth rate of market shares of the companies at the micro level economy, and profits at the macro level (Çaliskan, 2015).

This industrialisation also stimulated some changes in the mining industry, being currently known as Mining 4.0 (Jurdziak, Blazej, & Bajda, 2019). The primary goal for future will include the development of a decision support system for real-time production control and optimisation. Zelko and Spišák (2013) suggest that such system will be crucial for workers, once it will allow taking the necessary actions (in real time) to increase productivity and decrease energy consumption in underground mines. Singh et al. (2018) defend that digitalisation will play a defining role in the mining industry, bringing the value chain to a new level of development, changing the way companies interact with their employees, communities, environment, and government.

The digitalisation of data will include databases with geological, geophysical, and geochemical

information collected through remote sensing data, satellite images, the analysis made, and other relevant discoveries (Zelko & Spišák, 2013). However, this new technological era is important not only to increase production rates, but also to improve safety conditions. Despite the progress in the occupational health and safety field, the mining industry is still seen as a high-risk occupation (Nowrouzi-Kia et al., 2018; Verma & Chaudhari, 2017). Although accidents affect the workers and their families directly, they can also be considered a burden on the company, once they may entail significant costs deriving from property and equipment damage, as well as production losses (Ural & Demirkol, 2008). The same authors concluded that the most common fatal accident and injury types are blasting operation, mechanical haulage and fall from height form the border of excavated of high-wall.

This protocol aims to propose a methodology for a scoping review about the main digitalisation tools used in the mining industry. As a secondary result can be emphasised the need to acknowledge what is the type of information currently being digitalised.

2. METHODS

The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) was used in order to draw the scoping review protocol for this study (Tricco et al., 2018), as well as the Preferred Reporting Items for Systematic review and Meta-Analysis Protocol (PRISMA-P) checklist (Shamseer et al., 2015)

2.1. Eligibility criteria

In the scoping review, research articles, available official reports, thesis and dissertations with any kind of outcome related to the digitalisation in the mining industry or in similar works will be considered. Studies with mathematical models, when providing information about the data retrieve and computing will also be included.

Non-research articles (i.e. opinion articles, literature reviews) and studies which do not specify the used methodology for digitalising their data will not be considered.

2.2. Information sources

A search of literature from January 2015 to July 2018 will be performed.

The research includes some of the leading engineering databases: Web of Knowledge (Current Contents, Inspec and Web of Science), Scopus, and Academic Search Complete. Scientific journals databases are also going to be screened from: Association for Computing Machinery (ACM), Cambridge Journals Online, Elsevier (Science Direct), Emerald, Geologic Society of America (GSA), Ingenta, SAGE Journals Online and Taylor and Francis.

2.3. Search

The keywords defined to conduct the study are “digitalisation” and “modelling”, which are going to be sequentially combined with “open pit”, “open cast” and “mining industry”. All of these keywords are going to be separated by the Boolean operator “AND”, as the list as it follows:

(digitalization OR digitalisation) AND (modelling OR modeling) AND (“open pit” OR “open cast” OR “mining industry”)

In Scopus, for instance, the search will be conducted as it follows: TITLE-ABS-KEY (digitalization OR digitalisation AND "open pit"). After registering the number of papers, using the table provided in Duarte et al. (2018) the applied criteria were: Year (between 2015-2018), Document type (article and article in press), Source type (journals and trade publications), Language (English).

At the end of this process, the existence of potentially associated keywords related to the subject in the selected items is checked. If found, the new keywords will be used in new search combinations with the keywords previously used.

2.4. Selection of sources of evidence

After applying the first set of exclusion criteria, the review process will be divided into two levels of screening: (1) title and abstract review, so to exclude the articles which fall out of scope, (2) full-text review.

Regarding the first level, whenever any doubts concerning the title or abstract are raised, the temporary inclusion of the paper and its full-text will also be taken into consideration. Later, these works will be verified by two of the authors. If they have divergent opinions about their inclusion, a third party will determine their final destination.

For the second level, some minimum inclusion criteria will be applied in order to determine which papers to the full-text screen. After the full-text screening, the exclusion of any article will be justified and recorded.

The respective references of the selected articles will also be checked in order to find older articles not detected in the initial survey. In this process, other works of the authors of the selected articles, as well as the respective research centres will also be verified. This snowballing technique procedure will be repeated in the new selected articles until no more relevant information is obtained (Wohlin, 2014).

2.5. Data charting process

The selected studies are going to be collected and managed with Mendeley software for screening and de-duplication.

The research team will develop a data collection instrument (sheet form) according to the proposed problem, in order to confirm studies relevance, and, at the same time, to extract studies characteristics. After combining the results, any conflict will be solved by discussion between two authors; a third author will resolve any further conflicts.

2.6. Data items

The topics to be extracted will include, but not be limited to: publication details (author, title of the paper, year, country), objective, study area, dimensions, exploited material, software, software modules, used equipment, calibration, time of measurements, information data source, geologic data, methodology, results, conclusions, limitations. All of this information will be collected by one author and verified by the other two. In case there is any missing data, the authors of the studies will be contacted to retrieve the wanted information; in case it is not possible, the research team will discuss whether to exclude the paper from the study.

2.7. Critical appraisal of individual sources of evidence

The main author will collect the data and the team will discuss the results to improve the analysis and solve further disagreements. The texts will be fully screened in order to determine which were the digitalization techniques used in each case and how did the authors overcome the main issues found.

2.8. Synthesis of results

Because the study will be written in a scoping review form, the data synthesis will be carried through a narrative, based on information from the eligible papers assembled in the form sheets. The most important results will also be presented in table form.

AUTHORS' CONTRIBUTIONS

Study design and development: JD, FR, JSB

Full-text screening: JD

Data extraction: JD

Critical appraisal: JD, FR, JSB

Data analysis and interpretation: JD, FR, JSB

Draft of the protocol: JD

Support in the draft of the protocol: FR, JSB

All authors read and approved the final version.

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