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The relationship between organizational factors and residual risk in the mining industry – a protocol for updating a systematic review

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Abstract

Organizational factors have long been suspected to have the greatest influence on individual and group behavior in the workplace, although there is little research on their influence in mining workplaces. In addition, there is little research on the influence of organizational factors on residual risk management in the mining industry. Consequently, a Systematic Literature Review (SLR) is needed in order to explore and understand this gap. This paper is a protocol developed using guidance from the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 to update a previous systematic review on a similar topic. The SLR protocol provides information related to the three sections (Administrative Information, Introduction and Methods) suggested by the PRISMA-P 2015. Eligibility criteria is divided into inclusion and exclusion criteria, which also provides the scope of the review. The search strategy will involve identifying studies published between 1980-2018 from the following electronic databases (Scopus, Web of Science, Proquest, EMBASE, ASCE and CINAHL). Quality appraisal of studies will be achieved through a non-structured approach (for non-empirical studies) and a Mixed Methods Appraisal Tool for empirical studies. The review will be presented as a narrative synthesis due to the qualitative nature of the topic under review.

1. INTRODUCTION

1.1. Rationale

Despite huge investments in safety, mining companies continue to experience unsatisfactory safety performance, including serious and fatal accidents (Aliabadi, Aghaei, Kalatpour, Soltanian, & SeyedTabib, 2018; Cornelissen, Van Hoof, & De Jong, 2017; Department of Mines and Petroleum, 2016; Dragan, Georges, & Mustafa, 2017). In order to address the issue of workplace accidents and their causes, different approaches to accident prevention and safety models have been applied in high-risk industries (Turner & Pidgeon, 1994). Accident prevention in the mining industry, in particular, focuses on the application of a hierarchy of controls in which engineering controls that seek to eliminate or 'engineer out' hazards are most preferred (Horberry, Burgess-Limerick, & Fuller, 2013; Yin et al., 2017). More recently, human factors proponents have advocated for an approach that recognizes the centrality of humans in the design, implementation and operation of socio-technical systems (Lowe, 2008; Rollenhagen, 2010) According to this approach, human factors are recognized as possible contributors to workplace accidents, especially during accident investigation and in subsequent risk management processes. The work of Reason (1990, 1997, 2008, 2016) on active and latent failures illustrates the contribution of human attributes and fallibility on accident causation and often provides the basis for investigating human factors in complex high-risk industries.

Human factors refer to environmental, organizational and job factors including individual characteristics, which influence behavior at work in a way that can affect employee health and safety (Health and Safety Executive, 2018). The National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in Australia not only includes the issue of interrelatedness between organizational, job and individual factors in its definition of human factors but also adds the issue of human reliability as a factor in this interaction (NOPSEMA, 2014). Again, according to NOPSEMA (2014), these human factors should be investigated as possible root causes of workplace accidents. Human factors, by their very nature, are complex and therefore require in-depth analysis to arrive at the appropriate root cause in accident investigations. The practice of wrongly assigning root causes to accidents in safety-critical domains is not uncommon and could lead to more disastrous events occurring in future. A classic example of this is the Bhopal disaster, in which minor accidents that preceded the December 1984 gas leak were not properly investigated leading to risk-mitigating measures not adequately implemented (Chouhan, 2005; Eckerman, 2005). Repeat or recurrent accidents regularly occur in the mining industry (Department of Mines and Petroleum, 2016), indicating a deficiency in risk control effectiveness (pre-event) and during accident investigation processes (post-event).

There is a complex array of issues that need to be considered when looking at human factors in sociotechnical systems. These issues can be divided into four major categories: job factors, individual factors, environmental factors and organizational factors (NOPSEMA, 2015). The Health and Safety Executive (2009) in the United Kingdom suggested that organizational factors have the greatest influence on individual and group behavior, yet these factors are often overlooked during accident investigations. In their review of the role of behavioral factors on safety management in underground mines, Paul and Maiti (2007, p. 451) also acknowledged the increasing importance of organizational factors as "antecedents to the sequence of an injury". Other industry safety professionals also concur and advocate for a better understanding of organizational issues in order to create more effective culture-enhancing practices (Hopkins, 2006; Taylor, 2010).

Industry experience and research have shown that organizational factors in complex socio-technical systems can be divided into several attributes such as organizational safety culture, standards and procedures, training and competence, safety-critical communication, resource allocation, decision-making, safety leadership and organizational learning (Cooper, 2002; Health and Safety Executive, 2005). Following this perspective, the proposed systematic literature review (SLR) seeks to identify organizational factors that are prevalent in the mining industry and examine their relationship with other variables such as residual risk management, accident causation, repeat accidents and critical controls. As lagging indicators, repeat or recurrent accidents are themselves a measure of how well mining companies manage their residual safety risk. If a company experiences repeat accidents, then it implies that the risk controls or barriers implemented by the organization to mitigate against residual risk have failed, are ineffective or ill-targeted (International Council on Mining & Metals, 2013; Wilkinson & Petrie, 2014). This theoretical assumption is crucial in understanding the importance of improving residual risk management practices as a means of achieving sustainable safety performance in the mining industry. Therefore, the scope of the SLR will include the relationships between human factors (in general), organizational factors (in particular) and residual risk management in so far as accident causation in the mining industry is concerned.

Cornelissen et al. (2017) previously conducted a systematic literature review of determinants of safety outcomes and performance which identified a wide range of behavioral and circumstantial factors that impacted on employee safety in construction, offshore petrochemical, warehouse and manufacturing industries. Although similarities exist between their review and the proposed SLR, the fundamental differences lie in the population or domain under study (mining versus four different industries), the scope and the independent variables related to residual risk management. Furthermore, the review by Cornelissen et al. (2017) is intentionally broad, focusing on broad keywords such as safety performance, safety compliance and safety participation; an approach which can sideline important research published from the human factors domain. In contrast, this review seeks to identify specific studies conducted within the mining industry in order to enhance the understanding of organizational factors as important contributory agents to safety accidents and determinants of risk management practices in the industry. Even though this SLR protocol is not in the healthcare or clinical research domains, it will be reported using guidance from the Preferred

Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 checklist (Moher et al., 2015). It is intended to update a published SLR on a similar topic, entitled: "Organizational Factors, Residual Risk Management and Accident Causation in the Mining Industry: A Systematic Literature Review" (Nyoni, Pillay, Rubin, & Jefferies, 2018). This will improve the information presented by the previous SLR on gaps in knowledge and informing future research efforts.

1.2. Objectives

This SLR aims to identify research studies published on organizational factors, residual risk management and accident causation in the mining industry between 1980 and 2018. The 1980-2018 range is selected because significant research on organizational factors in safety-critical industries such as aviation, nuclear and chemical started towards the end of the 20th century in response to major industrial accidents and disasters, e.g., Bhopal and Chernobyl (Hsu, Lee, Wu, & Takano, 2008). In addition, it is also prudent to understand recent research work around the topic. The review also seeks to examine the relationship between organizational factors, residual risk and accident causation, including how these variables relate to the overall safety management processes in the mining industry. Specifically, the review is interested in answering the following research questions:

1) What is the relationship between organizational factors and accident causation in the mining industry?
2) What is the relationship between organizational factors and residual risk management in the mining industry?
3) What are the critical controls used to address organizational factors in the mining industry? Critical controls may also be error risk controls used to address human factors issues in the mining industry.

2. METHODS

2.1. Eligibility criteria

For the purposes of this review, only studies from peer-reviewed journal articles and conference proceedings would be included. Conference proceedings are included because a significant amount of research and information sharing within the mining industry usually takes place in industry-specific conferences. Studies will be selected according to the criteria outlined below.

Inclusion criteria

Published empirical studies will be included if:

a) They focus on the broad domain of human factors in the mining industry. Those studies that pay attention to organizational factors in the mining industry will be given preference. In this context, the mining industry refers to the total process cycle involved in the extraction and processing of mineral ore and coal.
b) They focus on the causes of incidents in the mining industry. Any particular focus on repeated incidents will also be given preference due to the hypothetical linkages between repeated incidents and residual risk management.
c) They examine organizational factors and residual risk management in the context of accident causation in the mining industry
d) They focus on the critical controls used to address safety risks associated with organizational factors in the mining industry
e) They focus on the gaps in knowledge or understanding of organizational factors in the mining industry
f) They focus on human factors in other high-risk industries that include mining, for instance, a study that looks into human factors in construction, mining and manufacturing industries.
g) They are published in peer-reviewed journals, conference proceedings and in the English Language.

h) They are published between 1980 and 2018.

Exclusion criteria

Studies will be excluded if:

a) They focus on organizational factors in irrelevant industries outside the minerals industry, for instance, traditional non-high-risk industries such as information technology (IT), health, education etc.

b) They focus exclusively on a particular high-risk industry that excludes mining, for instance, aviation, construction, chemical etc.

c) They focus on other human factors such as environmental, job, ergonomic and individual factors while excluding organizational factors. However, studies that consider various categories of human factors with specific mention of organizational factors as one of the categories will be included.

d) They focus on illegal mining and artisanal/small-scale mining.

e) The literature was published prior to 1980.

f) They are from non-refereed sources. Unpublished literature will also be excluded.

g) They are published in non-English languages.

h) They are duplicates.

2.2. Participants/population

a) Formal mining companies excluding illegal mining syndicates and artisanal mining

b) Group collectives such as managers, supervisors and workers

c) All types of mining (e.g. underground, surface, quarries)

2.3. Intervention(s)/exposure(s)

The literature review will consider studies that investigate organizational factors in the mining industry; the current understanding, their influence, limitations, gaps, linkages and key concepts related to residual risk management and accident causation.

2.4. Comparators(s)/control(s)

Different methods of mining, for instance, surface/open-pit versus underground mining, and different commodities such as coal and metalliferous.

2.5. Information sources

Six online databases will be selected to provide the primary data of interest. These are Scopus, Web of Science, Proquest, EMBASE, ASCE and CINAHL. Full-text articles will be obtained through an online facility called “Find full-text” in EndNote, which enables automatic searching and downloading of full texts for selected records. Some full-text articles will also be requested through the local university library. Where full-text articles cannot be found in the public domain, authors will be contacted via email or ResearchGate accounts requesting their full-text articles.

2.6. Search strategy

The search strategy will involve identifying key articles in the following electronic databases from 1980-2018 (Scopus, Web of Science, Proquest, EMBASE, ASCE and CINAHL). The aim is to capture as much literature as possible that examines the relationship between organisational factors and residual risk management in the mining industry. Therefore, our search strategy will include both broad terms and specific terms such as the following keywords:

Human factor, behavi* factor*, organi?ational factor*, risk*, safety, accident*, incident*, mining, miner**

Table 1 shows a draft search strategy to be used for Scopus.

Table 1. Draft search strategy to be used for Scopus

Parameter	Values
Search Format	Article Title-Abstract-Keywords
Keywords Entry	(TITLE-ABS-KEY ("human factor*" OR "behavi* factor*" OR "organi?ational factor*") AND TITLE-ABS-KEY (risk* OR safety OR accident* OR incident*) AND TITLE-ABS-KEY ("mining" OR "miner*"))
Limits	
Published Date Range	1980 – 2018 (inclusive)
Document Type	Article and conference paper
Language	English

2.7. Condition(s) or domain(s) studied

a. Safety performance
b. Human factors
c. Organizational factors
d. Residual risk management
e. Mining industry
f. Accident causation

2.8. Study records

2.8.1 *Data management*

Search results from the electronic databases will be exported to EndNote using built-in import and export features. EndNote features and tools will be used to screen study records for duplicates and to automatically download available full-text records.

2.8.2 *Selection process*

The study selection process shall involve a simplified procedure adapted from (Cornelissen et al., 2017) to select the eligible full-text articles published between 1980 and 2018 (both years inclusive). A flowchart for this procedure is illustrated in Figure 1.

The review authors will independently screen the titles and abstracts yielded by the search strategy against the inclusion and exclusion criteria. Screening will be divided into abstract and full-text screening. In both cases, article records will be excluded based on irrelevant titles featuring key terms found in the exclusion criteria, such as artisanal mining, ergonomic exposures, psychological and individual factors. Studies will also be excluded due to irrelevant industries such as offshore oil and gas, nuclear, medical and construction. Some study records will also be excluded due to accessibility issues. However, the decision to exclude such articles will only be taken after making unsuccessful attempts to obtain full-texts from the relevant authors. Abstract and full-text screening will be undertaken by two independent reviewers. Disagreement on study selection will be handled through engagement and discussion between the two independent reviewers. A third reviewer will be available for any disputes that cannot be resolved through this process.

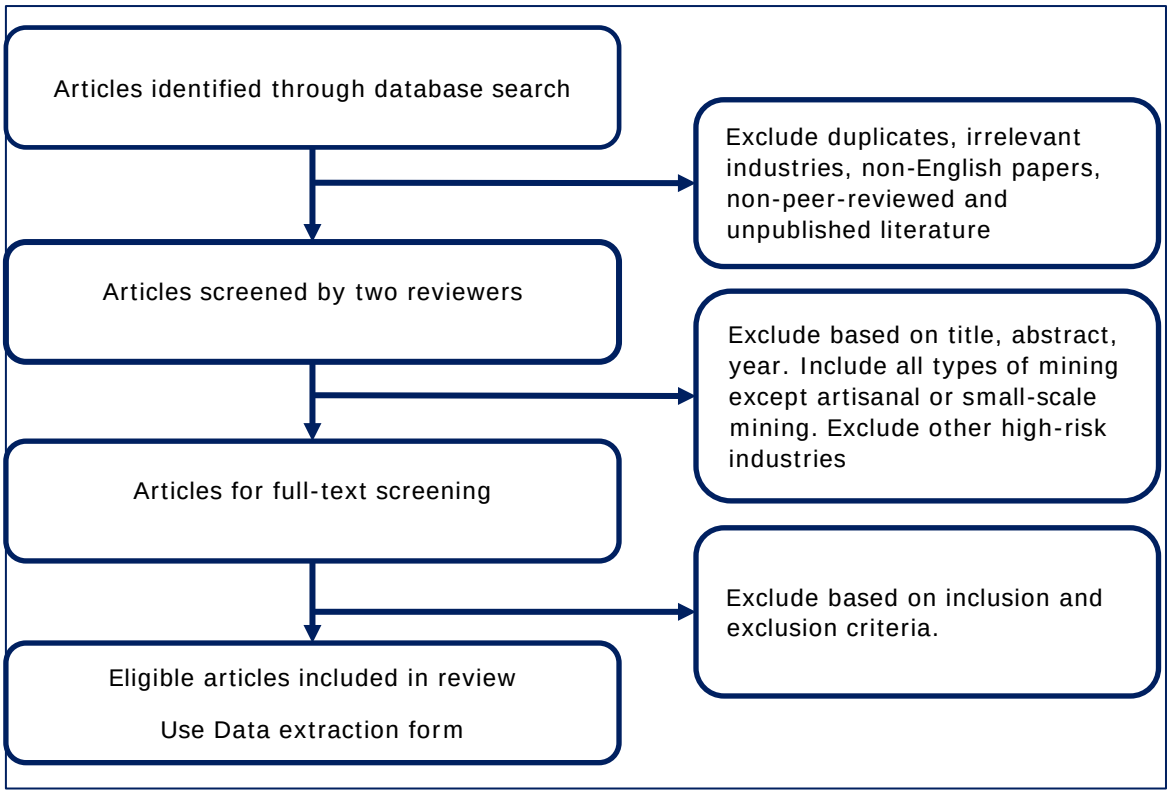

Figure 1. Flowchart for study selection. Adapted from Cornelissen et al. (2017)

2.8.3 *Data collection process*

Using guidance on systematic reviews from the Centre for Reviews and Dissemination (2008), a data extraction spreadsheet will be created in Microsoft Excel 2016 and used to capture information from the eligible studies. One researcher will undertake independent data extraction prior to discussion by three researchers who will provide critical analysis and confirmation.

2.9. Data items

Table 2 shows the type of information and list of variables to be included in the data extraction process.

Table 2. Example of data items to be included in data extraction

Type of information	Examples
General information	Researcher performing data extraction Date of data extraction
Identification features of the study	Unique identifying number, author(s), title of the study and year of publication
Study characteristics	Aim of the study, study design, sub-themes, research methods and tools
Participant/ Population characteristics	Industry, industry sub-group, conditions being studied
Results/ Study outcomes	Summary of results relevant to the research questions
Variables of interest	Identified organizational factors, relationships between organizational factors and accident causation, residual risk management, error-risk controls, critical controls, HF methods used or discussed
Additional information	Types of analysis, gaps for further research

2.10. Outcomes

2.10.1 *Primary outcomes*

The primary outcome will be the number of studies that examine the relationship between organizational factors, residual risk and accident causation in the mining industry. These studies will then be scrutinized in detail for secondary outcomes that include relationships

between different variables of interest.

2.10.2 *Secondary* outcomes

a) Identity and attributes of organizational factors in the mining industry – organizational safety culture, communication, operational supervision, procedures, resources, safety leadership and organisational learning

b) Attributes and outcomes of residual risk management

c) Geographic, theoretical and methodological gaps in the understanding of organizational factors

d) Theoretical approaches, design framework and methods used

e) Relationships between human factors, organization factors, residual risk management and accident causation

2.11. Risk of bias / quality assessment

To reduce the risk of bias for each study, two reviewers will independently assess the quality of eligible articles using two approaches, based on the nature of research designs. According to Crowe and Sheppard (2011), information from a variety of sources that are based on methodologically different research designs can be difficult to evaluate using a single critical appraisal tool. Consequently, critical appraisal of non-empirical studies such as reviews and theoretical papers will be achieved through a non-structured approach as suggested by the International Centre for Allied Health Evidence (2018). In this process, two reviewers will critically analyse individual studies as part of the reading process. In contrast, empirical studies will be critically appraised for theoretical and methodological quality using a Mixed Method Appraisal Tool (MMAT) adopted from Hong et al. (2018). Three categories of study designs, namely, quantitative, qualitative and mixed methods will be chosen as shown in Table 3. To further manage the risk of bias, a third reviewer will be available to resolve any disagreements between the two reviewers that cannot be resolved through discussion and consensus.

Table 3. Mixed Methods Appraisal Tool adapted from Hong et al. (2018)

Category of study designs	Methodological quality criteria	Responses			
		Yes	No	Can't Tell	Comments
Screening Questions (For all Types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
A. Qualitative	A1. Is the qualitative approach appropriate to answer the research question?				
	A2. Are the qualitative data collection methods adequate to address the research question?				
	A3. Are the findings adequately derived from the data?				
	A4. Is the interpretation of results sufficiently substantiated by data?				
	A5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
B. Quantitative descriptive	B1. Is the sampling strategy relevant to address the research question?				
	B2. Is the sample representative of the target population?				
	B3. Are the measurements appropriate?				
	B4. Is the risk of nonresponse bias low?				
	B5. Is the statistical analysis appropriate to answer the research question?				
C. Mixed Methods	C1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	C2. Are the different components of the study effectively integrated to answer the research question?				
	C3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	C4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	C5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

2.12. Data Synthesis

A systematic narrative synthesis (Popay et al., 2006) will be provided with information presented in textual and tabular format to summarize and explain study characteristics, outcomes of the quality appraisal, outcomes from individual studies and the relationship between variables of interest. Pie-charts and Venn diagrams will also be used to show proportions of study characteristics and relationships between different variables. Ultimately, the narrative synthesis will explore and identify gaps around the topic that could inform future research and suggest possible research agenda to address those gaps.

2.13. Analysis of Subgroups or Subsets

Depending on the number of relevant articles, analysis will also be broken down into the following subsets or subgroups:

a) Type of mining method (underground versus surface/open-pit mining)

b) Commodity being mined (Coal mining versus metalliferous mining versus quarries versus other non-metals)

c) Geographical region (continent/sub-continent)

2.14. Author Contributions

W.N. designed and prepared the review protocol. M.P., M.R. and M.J. provided oversight and critical review of the protocol.

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2.17. Conflict of Interest

None known.

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