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A SYSTEMATIC LITERATURE REVIEW ON THE CONTRIBUTING FACTORS OF SAFETY CULTURE IN MINING INDUSTRY

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Abstract: Governments make billions of dollars from mining activity. The rates of fatalities and disasters related to the mining industry seem to be worrying worldwide. One of the solutions is to promote and strengthen a good safety culture practice at the mine site. However, there is still a lack of papers discussing the contributing factors of safety culture in the mining industry. Thus, this systematic review aimed to investigate the contributing factors of the safety culture or mining industry from 2020 to August 2023 using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Based on SLR, the top five contributing factors to safety culture were safety competency, management commitment, safety training, the safety environment, and safety rules. In order to help mine owners, this systematic review study will provide the latest knowledge on the contributing factors to creating a safety culture in the mining industry. The study also takes into account miners, the government, and policymakers so that all parties may work together to reduce mining accidents in the future.

Keywords: S mining industry, mining accidents, preferred reporting items for systematic reviews and meta-analyses, safety culture, systematic literature review.

Introduction

The mining industry is a critical sector that is crucial to global economies. It is responsible for extracting valuable minerals and resources essential for various industries, including manufacturing, construction, and energy production. However, the mining industry is also known for its inherent risks and hazards, making safety a paramount concern. The increase in exposure to air pollution, toxic chemicals, and strenuous work activities poses significant health and safety risks for employees in the mining industry (Owoeye-Lawal *et al*., 2022). These risks can severely affect their well-being and result in fatal injuries. According to recent data, the mining industry has one of the highest incidence rates of fatal injuries among all industry divisions, making it one of the world's most dangerous occupations (Owoeye-Lawal *et al*., 2022).

According to the Mining Market Report for 2023, the global mining market grew from USD2022.6 billion in 2022 to USD2145.15 billion in 2023 at a compound annual growth rate (CAGR) of 6.1% (https://www.thebusinessresearchcompany.com). However, due to the nature of mining operations, which involve high-risk jobs and a harmful environment, there is a potential for the occurrence of near misses, accidents, and incidents; therefore, awareness and practises of a good safety culture at the mine site must be

encouraged. In addition, this calls for implementing a strong safety culture within the mining industry to mitigate these risks and ensure the well-being of workers.

Safety culture refers to the shared beliefs, attitudes, and values that prioritise workplace safety and influence individuals' and groups' behaviour. Creating a strong safety culture in the mining industry is crucial for preventing accidents, reducing injuries, and promoting a safe working environment. Moreover, a strong safety culture can also have positive socio-economic consequences for workers and society as a whole. Promoting and understanding safety culture in high-risk industries, such as aviation, healthcare, and mining, has become a critical process in recent years (Litchfield *et al*., 2021). Furthermore, there are numerous definitions of culture because it is a difficult concept to define (Spencer-Oatey 2012). Safety culture is defined by the Institution of Occupational Safety and Health (IOSH) (2015) as a set of shared values (what matters) and beliefs (how things operate) that combine with an organisation's structure and control mechanisms to produce behavioural norms (the right way to do things).

According to Ismail *et al*. (2023), safety culture refers to the elements or components of organisational culture that affect attitudes and behaviours and, in turn, the degree of safety inside the organisation. According to Kalteh *et al*. (2018), they stressed reducing safety accidents by promoting a safety culture. Also, they verified it by conducting a study on the relationship between safety culture, safety climate, and safety performance. Previous researchers have developed several safety culture models, including the Bandura Reciprocal Determinism Model (Bandura, 1986), Schein's Theory (Schein *et al*., 1992), Geller's Theory (Geller, 1994; Geller, 1997), Reason Safety Culture Model (Reason *et al*., 1997), Guldenmund's Three Layered Organizational Culture (Guldenmund, 2000), and the Reciprocal Safety Culture Model by Cooper (Cooper, 2000), as shown in Figure 1.

A strong safety culture is beneficial and necessary across all job market levels, including workers, clients, and governments. Creating a strong safety culture in the mining industry requires a shared understanding of the importance of safety and active participation in generating ideas and strategies to reduce risks, accidents, and ill health. In recent years, numerous studies have been conducted on different aspects of safety culture in the mining industry. For example, Grodzicka and Szlązak (2016) studied various critical factors of safety culture, such as the management of work safety, safety culture within mining crews, the formation of safe behaviours among miners, and risk rescue operations in mines (Tonasa *et al*., 2020).

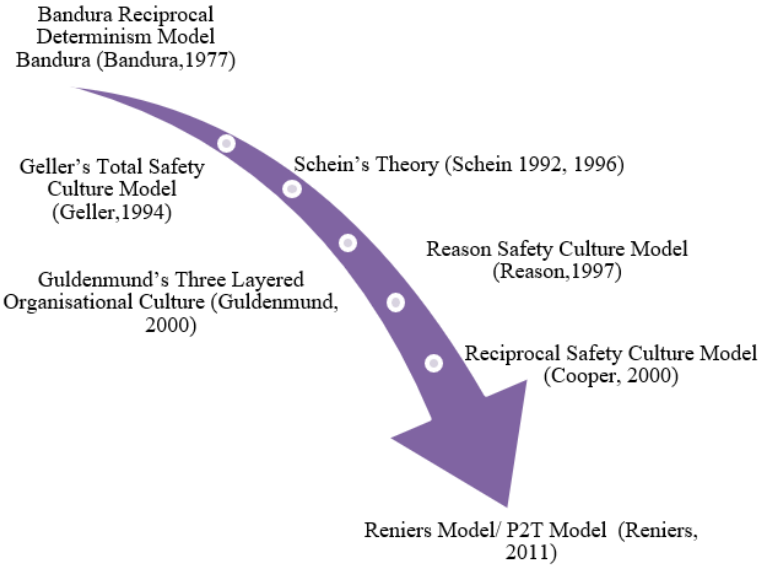


Figure 1: Various safety culture models

Despite having various studies or research related to the mining industry, there is a scarce systematic literature review (SLR) conducted that reviews or highlights the full coverage of the exact contributing factors of safety culture in the mining industry needed worldwide. The main research question guiding this systematic review is: What are the latest contributing factors to the safety culture required in the mining industry? It is important to understand this and make suggestions to improve this sector, especially in relation to mining accidents. Therefore, the objective of this SLR was to investigate the contributing factors of the safety culture or mining industry in the years 2021–2023 by using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Methodology

In conducting an SLR on the contributing factors to safety culture in the mining industry, the PRISMA methodology was employed. The PRISMA approach was chosen as it provides a comprehensive and structured framework for conducting systematic reviews and ensures transparency and reproducibility of the review process (Hizam-Hanafiah *et al*., 2020). The review process followed the PRISMA guidelines, which include the following steps: identification, screening, eligibility, and inclusion (Talukder *et al*., 2021). By following the PRISMA methodology, the SLR ensured a comprehensive and rigorous approach to identifying and including relevant studies on the contributing factors of safety culture in the mining industry.

Identification Phase

Identification, the first stage of the systematic review process, was completed in August 2023. The procedure involved identifying keywords for use in information searches. It is recommended to present at least one database, according to Moher *et al*. (2009).

ScienceDirect, Scopus, Springer, Emerald, and Taylor & Francis were the chosen indexed databases in this case. They were selected since they are renowned for publishing scholarly articles and are regarded as the top indexing systems for citations. The search string used for five databases is shown in Figure 2. This process yielded 207 articles from ScienceDirect and 155 articles from Scopus. Springer, Taylor, and Emerald recorded 139, 279, and 105 documents, respectively, related to the search string as shown in Figure 2. The total number of articles obtained was 705, which were further reviewed in the screening stage.

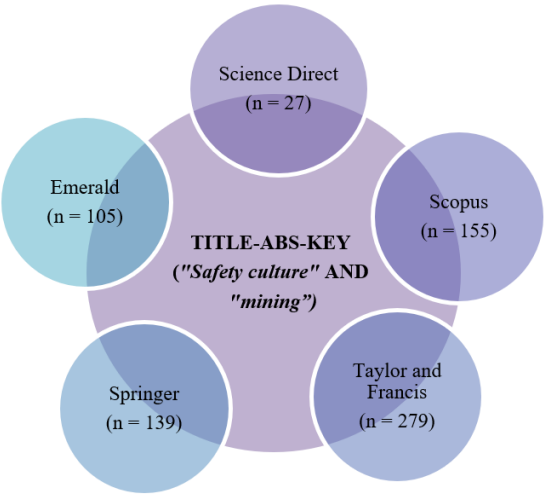


Figure 2: Search string and five databases used in the identification stage of PRISM with the total number of articles (n) for each database

Screening Phase (Inclusion and Exclusion Criteria)

The second phase, which is depicted in Figure 2 and Figure 3, was applied to the 705 identified articles from the two databases based on the search strings (refer to the identification phase). Articles are included or excluded throughout the screening process based on criteria chosen by the authors and with the help of the relevant databases. The eligibility, inclusion, and exclusion criteria were established throughout the screening phase to locate appropriate papers to be included in the systematic review process. The authors of the SLR study established the inclusion and exclusion standards, which are displayed in Table 1.

Based on the total number of related publications that were retrieved and needed to be assessed, a publishing timetable for the years 2020 to August 2023 was first chosen. Based on the different kinds of papers, the second inclusion criterion, article journals, was selected as this criterion from both databases. Because they were not regarded as primary sources, review articles, books, book chapters, and conference proceedings were not included. Language served as the third factor for inclusion and exclusion. To prevent misunderstandings and challenges with translation, all non-English language materials were disregarded, as shown in Table 1. Following identification, the 705 articles underwent

screening. Here, 175 articles were collected following the screening phase (see Table 1 and Figure 3).

Table 1: The criteria for inclusion and exclusion

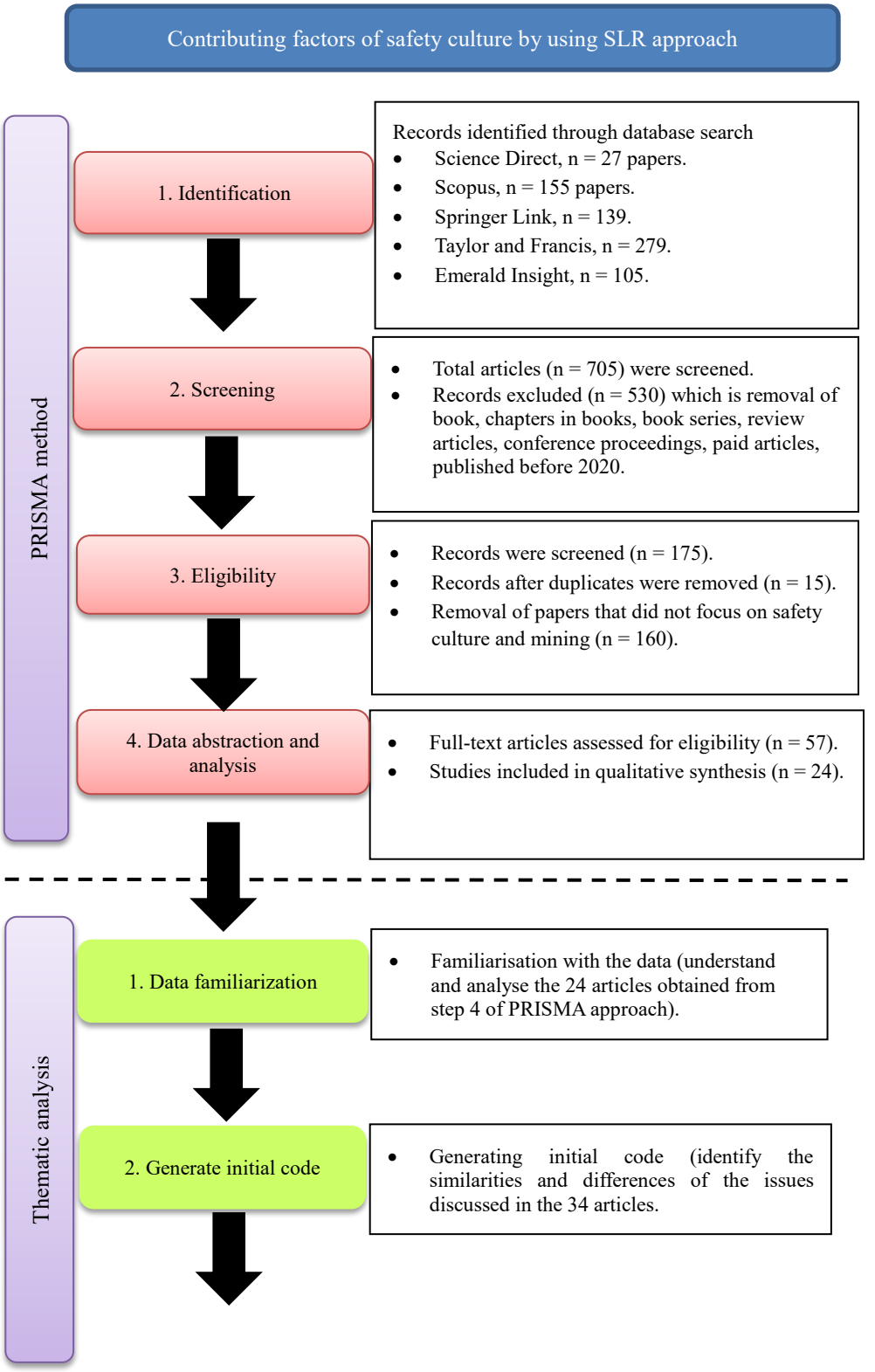
Criteria	Inclusion	Exclusion
Publication timeline	2020 to August 2023	2019 and before
Document type	Journal (research articles)	Conference proceedings, Journals (systematic review), chapters in books, book series, books, etc.
Language	English	Non-english

Eligibility and Duplication Exclusion (Manual screening)

Articles are manually included or excluded throughout the eligibility process based on the requirements specified by the authors. The items that did not meet these requirements were removed after a careful evaluation of the ones that did. Duplicate documents were eliminated prior to the eligibility check. The eligibility process left with 57 papers after 15 articles that were similar in both databases were disqualified from the following stage. These were manually reviewed for literature on mining accidents and the inclusion and exclusion criteria from previous screening procedures. In the end, 34 publications were chosen for the comprehensive literature review of mining accident research trends.

Data Abstraction and Analysis

Data analysis and abstraction account for the fourth stage. The 57 chosen papers (studies) were examined, reviewed, and analysed. Reviews were built on particular studies that focused on and suited the research issue. After reading the research titles and abstracts, it was time to thoroughly (in-depth) read the entire article contents in order to extract the studies' pertinent topics and sub-themes for the current study. An integrative review—a form of review that synthesises several study designs (qualitative, quantitative, and mixed methods)—was carried out. A thematic analysis was carried out to identify themes related to the factors that make up safety culture. At this stage, only 34 articles met the requirements, as shown in Table 3. The main issues, similarities, and differences highlighted and portrayed in the 34 articles were identified and categorised; this is known as thematic analysis. According to Nowell *et al*. (2017), six steps were used in the thematic analysis of this SLR study to build themes that were appropriate for qualitative analysis. The steps of thematic analysis and the summary of PRISMA for the SLR study have been summarised as shown in Figure 3 and Table 3.


Contributing factors of safety culture by using SLR approach
PRISMA method
1. Identification
Records identified through database search
Science Direct, n = 27 papers.
Scopus, n = 155 papers.
Springer Link, n = 139.
Taylor and Francis, n = 279.
Emerald Insight, n = 105.
2. Screening
Total articles (n = 705) were screened.
Records excluded (n = 530) which is removal of book, chapters in books, book series, review articles, conference proceedings, paid articles, published before 2020.
3. Eligibility
Records were screened (n = 175).
Records after duplicates were removed (n = 15).
Removal of papers that did not focus on safety culture and mining (n = 160).
4. Data abstraction and analysis
Full-text articles assessed for eligibility (n = 57).
Studies included in qualitative synthesis (n = 24).
Thematic analysis
1. Data familiarization
Familiarisation with the data (understand and analyse the 24 articles obtained from step 4 of PRISMA approach).
2. Generate initial code
Generating initial code (identify the similarities and differences of the issues discussed in the 34 articles.

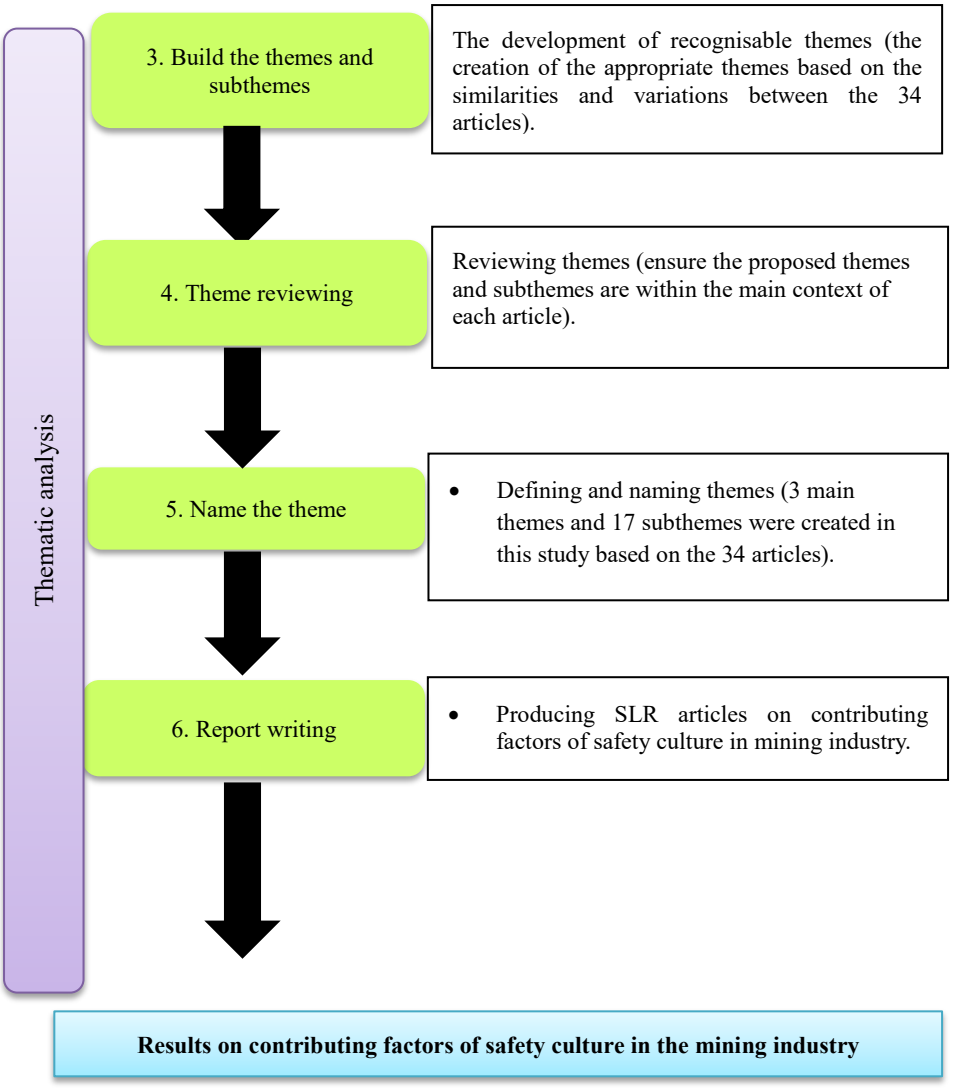


Figure 3: The process flow of the SLR study with the combination of the PRISMA and thematic analysis approach
(Adapted from Moher *et al*., 2009; Nowell *et al*., 2017; Noraishah *et al*., 2021)

The SLR was successfully conducted to investigate the contributing factors of safety culture in the mining industry. By applying a thematic analysis based on Nowell *et al*. (2017), 24 articles were carefully studied. They produced 3 main themes consisting of behavioural dimension (52.9%), situational dimension (35.30%), and psychological dimension (11.76%), with the 9, 6, and 2 subthemes or contributing factors identified as shown in Table 3, Figure 2, and Figure 3. The results from the thematic analysis of the safety culture in mining industry studies are shown in Table 3.

Results

Safety Culture Studies from Various Countries

A number of safety culture studies in the mining industry from various countries between 2019 and 2023 were established. Based on the PRISMA method, 24 articles were selected from 10 countries, which are China, Turkey, India, Kenya, Bosnia, Brazil, South Africa, Iran, Poland, and the United States of America. China was a leading country for published articles, with 11 articles (studies) relating to safety culture in coal mining, followed by Kenya (2 studies in a gold mine) and Turkey (2 studies in a coal mine), as shown in Table 2. Furthermore, 15 studies were quantitative articles (QN), 13 studies used mixed methods (MM), and 6 studies were qualitative studies (QL), as shown in Table 3.

Table 2: Type of mining and number of studies from various countries

Type of Mining	**Numbers of Study**	**Country (n = Number of Articles)**
Coal	15	China (11) Turkey (2) Iran (1) India (1)
Gold	2	Kenya (2)
Iron ore	1	Brazil (1)
Not mentioned	6	Poland (1) South Africa (1) USA (2) Bosnia (1)
Total	**24**	

Table 3: SLR results on safety culture in the mining industry from 2020 to 2023

Authors	Year	Type of Study	Type of Mine	Country	Phycological Dimension		Situational Dimension						Behavioural Dimension								
					SA	MCON	SR	RE	SE	WE	JS	EF	MC	AW	MO	ST	COMM	RR	SI	SM	SCO
(Rose *et al*., 2023)	2023	MM	Iron ore	Brazil	/	/	/	/	/			/	/	/	/	/	/		/		/
(Xie *et al*., 2023)	2023	QN	Coal	China	/		/						/	/	/	/	/		/	/	/
(Yuan *et al*., 2023)	2023	QN	Coal	China	/				/												
(Rahimdel *et al*., 2022)	2022	QN	Coal	Iran			/		/	/			/	/	/	/	/		/	/	/
(Niu *et al*., 2022)	2022	QN	Coal	China	/	/							/		/					/	
(Wang *et al*., 2022)	2022	MM	Coal	China	/		/	/	/			/	/	/	/	/	/		/	/	/
(Patyk *et al*., 2022)	2022	MM	Not mentioned	Poland					/				/	/							/
(Li *et al*., 2022)	2022	QL	Coal	China	/	/	/		/			/	/	/	/	/			/		/
(Musonda *et al*., 2021)	2021	QN	Not mentioned	South Africa	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
(Murphy *et al*., 2021)	2021	QN	Not mentioned	USA			/						/		/	/	/			/	/
(Ajith *et al*., 2021)	2021	MM	Gold	Kenya	/	/	/		/	/	/	/	/	/	/		/		/	/	/
(Moore *et al*., 2021)	2021	QN	Not mentioned	Bosnia	/		/	/	/						/	/	/		/		/
(Atay & Terpstra-tong, 2020)	2020	QL	Coal	Turkey	/	/	/	/	/	/		/	/	/	/	/			/		/
(Dursun, 2020)	2020	MM	Coal	Turkey	/		/		/			/			/	/			/	/	/
(Wu *et al*., 2020)	2020	MM	Coal	China	/	/	/		/				/	/	/	/	/		/	/	/
(Yorio *et al*., 2020)	2020	QN	Not mentioned	USA				/					/			/	/				
(Miao *et al*., 2020)	2020	MM	Coal	China				/	/							/					/
(Zhang *et al*., 2020)	2020	MM	Coal	China	/		/		/				/	/		/	/		/		/
(Fu *et al*., 2020)	2020	QN	Coal	China	/		/	/	/				/	/		/					/
(Rubin *et al*., 2020)	2020	QN	Coal	China	/		/	/	/		/		/			/	/	/			/
(Jiang *et al*., 2020)	2020	QN	Coal	China	/		/	/	/				/	/		/		/	/		/
(Bhattacharjee *et al*., 2020)	2020	QL	Coal	India			/	/	/				/	/		/	/				/
(Liu *et al*., 2020)	2020	QL	Coal	China				/					/	/							/
(Ajith *et al*., 2020)	2020	QN	Gold	Kenya									/			/					/

Psychological Dimension	Situational Dimension	Behavioural Dimension	Type of Study
SA = Safety Attitude	SR = Safety Rules	MC = Management Commitment	QL = Qualitative Study
MCON = Management Concern on Workers	RE = Reporting	AW = Safety Awareness	QN = Quantitative Study
	SE = Safety Environment	MO = Monitoring and Supervision	MM = Mixed Mode Study
	WE = Employee Welfare (health and safety)	ST = Safety Training	
	JS = Job Satisfaction	COMM = Safety Communication	
	EF = External Factors	RR = Reward and Recognition	
		SM = Safety Management	
		SI = Safety Investment	
		SCO = Safety Competency	

A total of 34 articles were obtained and analysed based on the PRISMA approach. The results are presented in statistical form, such as the percentages of the themes and how frequently the subthemes appeared in the articles, as shown in Table 2 and Figure 4, respectively. The detailed results of the SLR on safety culture study in mining studies are summarised in Table 3. According to Figure 4, the top five contributing factors of safety culture were management commitment, followed by safety competency, safety training, safety environment, and safety attitude.

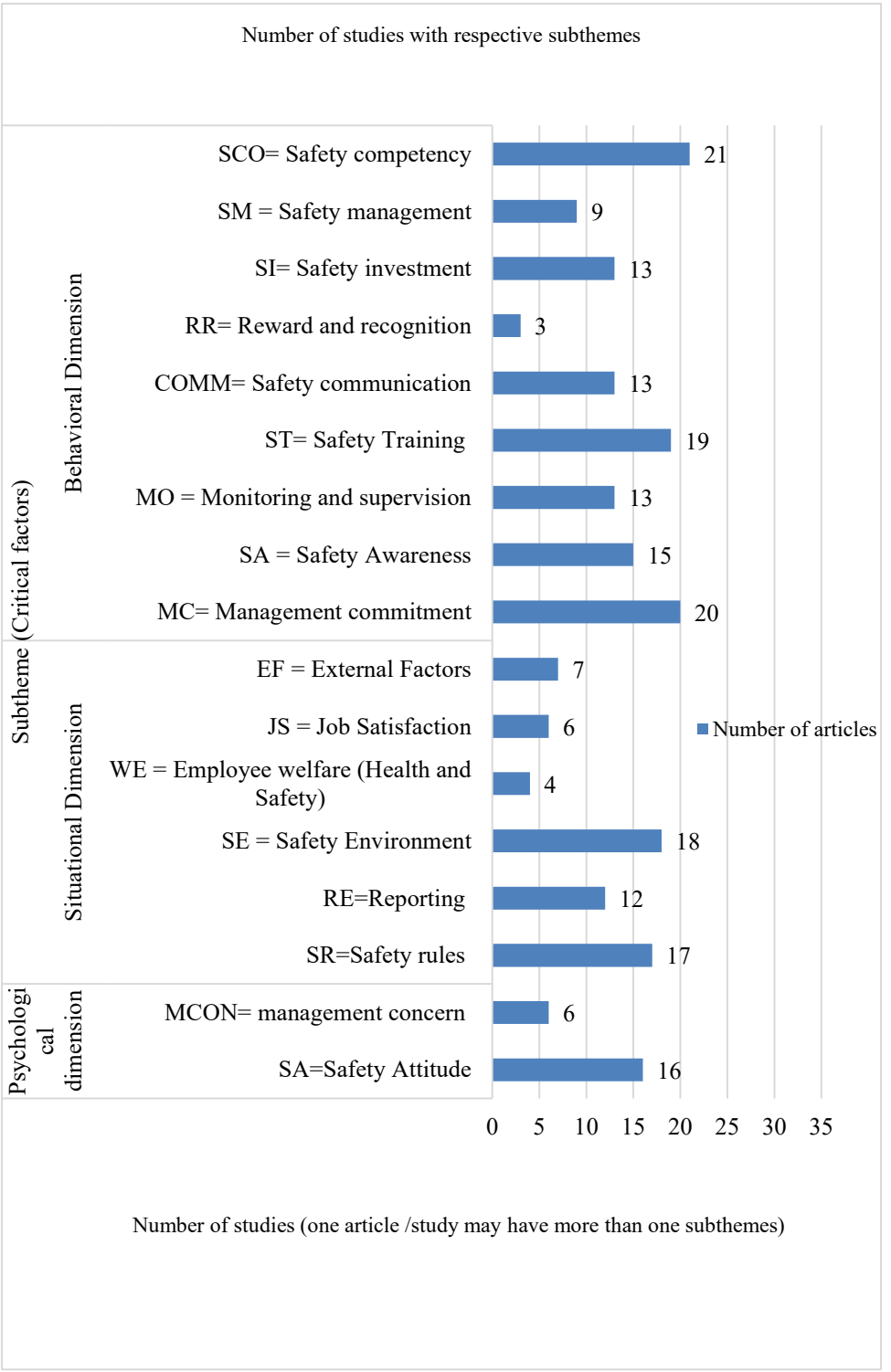


Figure 4: Distribution of articles by theme and sub-themes (contributing factors) in the SLR study

Discussion

The nature of mining activities is unique. It is combined with various expertise, starting from geological survey for mineral exploration and up to mineral processing and production, as well as marketing and businesses. This was demonstrated by the fact that in order to open a certain mine, whether it be for surface mining or underground mining, mining specialists' opinions, critical judgement, and specifics must be taken into account. The depth of experience that mining experts possess is essential since mining operations necessitate considerable financial commitment as well as highly careful planning (Ismail *et al*., 2022a). To make mining activities safe and sustainable without the involvement of mining accidents or disasters, practising a good safety culture at the mining workplace is really demanding (Ismail *et al*., 2021). Figure 5 shows the summary of all 17 contributing factors to developing a safety culture in the mining industry.

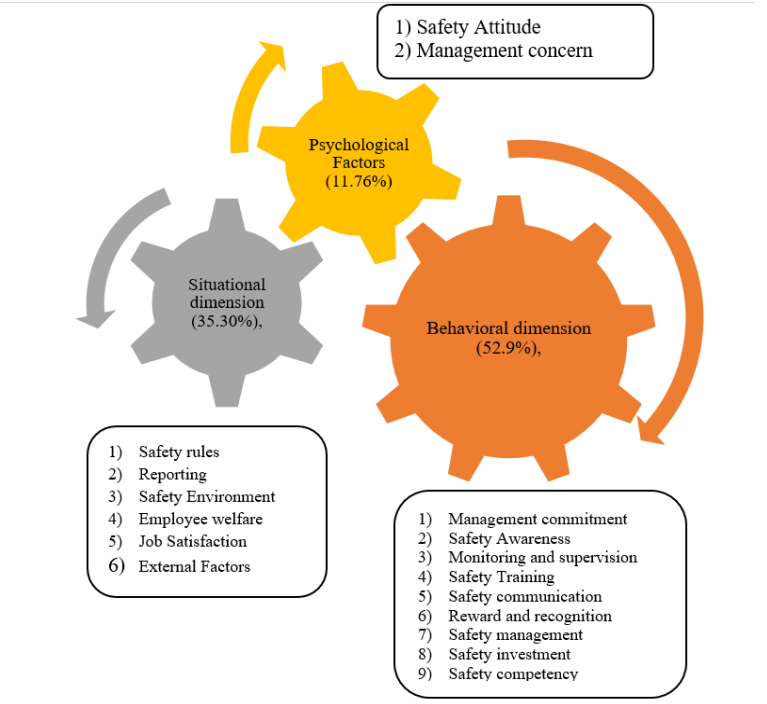


Figure 5: Contributing factors of safety culture in the mining industry

Behavioural Dimension

The biggest percentage of themes came from behavioural dimensions, with 52.9% in the SLR study. It consists of nine main contributing factors to safety culture, as shown in Figure 5. The top ranks of contributing factors for the behaviour dimension were led by safety competency (21 studies), followed by management commitment (20 studies), safety training (19 studies), safety awareness (15 studies), safety investment (13 studies), safety

communication (13 studies), monitoring and supervision (13 studies), safety management (9 studies), and reward and recognition (3 studies).

The first ranking of contributing factors to safety culture is safety competency. Safety competency refers to the knowledge, skills, and experience that workers possess to effectively contribute to a safety culture. Previous educational background and working experience are important components of safety competency. Workers with a solid educational background and relevant working experience are more likely to be aware of the importance of a safety culture and to understand how to prioritise safety while performing their jobs. To develop and enhance the safety competency of mine workers, it is crucial for mining management to provide safety training. Safety training allows workers to gain the necessary knowledge and skills to maintain a safe working environment. Investing in safety training programmes demonstrates management's commitment to the well-being of their workers and the promotion of a strong safety culture. According to Peters, Vaught, and Mallet, research on health and safety training in mining suggests that major improvements in miners' safety training are needed to ensure effective and comprehensive training programmes (Zujovic *et al*., 2020). One of the key aspects of safety training is to ensure that workers are equipped with the necessary skills and knowledge to identify potential hazards, handle emergencies, and implement safety practices. Furthermore, allocating a budget for mine workers to attend training, courses, or short courses specifically related to their work at the mine site is essential.

Moreover, management commitment toward a safety culture is also critically important in ensuring the well-being and safety of mine workers. This is evident from a study conducted by Ismail *et al*. (2021) and Ochoa *et al*. (2022), where one of the key factors influencing safety culture was identified as management commitment. According to Wang *et al*. (2022), safety management practices, including safety training, have a positive impact on safety culture (Zujovic *et al*., 2020). Management commitment to safety culture plays a pivotal role in establishing and promoting a positive attitude towards safety among mine workers. However, management commitment alone is not enough to ensure a strong safety culture. To further enhance safety culture, it is essential to focus on improving the safety competency of mine workers.

Situational Dimension

The second largest theme was the situational dimension, which can refer to “what the organisation has” based on Copper's Safety Culture Model (Cooper, 2000). The top three contributing factors for the situational dimension were led by the safety environment (18 studies), followed by safety rules (17 studies), and reporting (12 studies). According to Noraishah *et al*. (2021), organisational deficiencies, poor workplace environments, mechanical failure, and inexperienced workers are among the contributing factors to mining accidents. Furthermore, the human factor has long been argued to be the primary cause of industrial accidents in industries including mining, manufacturing, construction, and others. However, a study by Ismail *et al*. (2022b) revealed that organisational factors contribute to around 53% of mining accidents, followed by human factors (27%) and situational factors (20%). It is important to give good exposure and awareness to mine

operators or mine owners to plan strategically in order to ensure the safety of mine workers as their utmost priority. This is in line with the results found in this SLR study, whereas the safety environment was the highest reported in this study. According to Figure 4, the safety environment is the highest contributing factor for the situational dimension of the mining industry, with 25 out of 34 articles reported on it. The mining management or mine owner must have good execution and implementation of safety policies and rules. The workers must abide by the rules and ensure safety is their top priority while working at my workplace.

Moreover, a study conducted by Noraishah *et al*. (2021) indicated that mechanical failure was the primary cause of accidents in the mining sector. The mine owner must be concerned about the safety of all machinery involved with mining activities. For example, the poor safety environment, such as the poor structure of underground coal mines, poor ventilation systems and shafts, and poor mechanical design, are contributing factors for initiating mining accidents or disasters. Failure to provide good equipment to workers can also contribute to mining disasters. Another important contributing factor to the situational dimension is safety reporting, which is located at the third rank of the situational dimension in this study. Any incidents, near misses, and accidents must be reported to the Safety and Health Officer or the person in charge. However, the presence of an unsafe attitude and unsafe behaviour among mine workers neglect the potential risk of initiating accidents must be overcome. Some sort of punishment can be implemented for those workers who show bad behaviour at the workplace. A good mine worker can be rewarded to motivate them to practise a good safety culture while performing their job.

According to the SLR study, external factors are also highlighted in the situational dimension. As we know, all the rules and regulations in the mining industry will directly follow the rules and regulations provided by the government itself. However, the lack of efficient industrial self-regulation and the inadequate government support mentioned by Rose *et al*. (2023), Musonda *et al*. (2021), and Terpstra-Tong (2020) are considered external factors in this study. In some cases, the authorities do not have clear rules and regulations for their local mining company, and the consequence is that the mine owner takes them for granted, just ignores the regulations, and tends to get a high profit without prioritising safety aspects and also the safety and health issues of their mine workers. Therefore, to ensure a good practice of safety culture exists at my workplace, all these issues must be overcome.

Psychological Dimension

According to Cooper's safety culture model (Cooper, 2000), psychological dimensions reflect “what people feel”. The SLR revealed two important contributing factors to safety culture in the mining industry: (i) safety attitude and (ii) management concern. According to Niu and Liu (2022), miners' psychological safety is a kind of psychological perception or subjective feeling that is more important for workplace morale than interpersonal trust. Based on this study, only two contributing factors to safety culture were obtained, which are safety attitude and management concerns for workers. Based on previous literature, only a few studies have looked at the impact of psychological empowerment on workplace

safety, and even fewer have combined the following three factors: Safety, technology, and empowerment in mining companies (Ochoa Pacheco *et al*., 2022). The significance of attitudes towards safety (Amponsah-Tawiah *et al*., 2016), the effects of a safety culture in organisations (Cooper, 2000; Wu *et al*., 2010), and the connection between leadership empowerment behaviour and both safety and safety teamwork have all been extensively discussed in the literature (Tong *et al*., 2015; Tong *et al*., 2019).

Furthermore, according to Ameer *et al*. (2022), who conducted a study at an iron ore mine, to reduce the miners' unsafe behaviour, the organisation must increase its safety performance. Concern from management for employees was another crucial factor. It involves the manager's or leader's concern for the worker's mental and physical wellness. For instance, a few of the mining experts mentioned the health problems mine workers face. Some mining owners do not view their employees as their key assets. For instance, due to budgetary limitations, small-scale mine operations do not prioritise the health of their employees, and the management does not offer the employees annual health examinations (Ismail *et al*., 2023).

Future Directions and Recommendations

Mine owners, operators, and authorities can benefit from this study by gaining a deeper understanding of the significance of safety culture in the mining industry. They can use the findings to develop and implement effective safety protocols and practices, leading to a safer working environment for mine workers. By prioritising safety culture, mine stakeholders can improve safety performance and enhance organisational commitment. It is recommended to conduct safety culture assessments for various mining companies, whether small or large, mining scale operations to investigate the safety culture practises between both operations. This assessment could help identify the critical safety culture for both mining operations and how improvements can be made to find the best solution to promote a good safety culture in the mining industry.

Conclusion

Based on SLR, behavioural dimensions (52.9%), situational dimensions (35.30%), and psychological dimensions (11.76%) were obtained to construct a safety culture. The top five contributing factors to safety culture were safety competency, management commitment, safety training, the safety environment, and safety rules. This study on safety culture is useful to various stakeholders involved in the mining industry, including mine owners, mine operators, safety and health officers, as well as mine workers and local authorities. Understanding the importance of contributing factors in safety culture, as highlighted in this study, is essential for all these parties to ensure the overall safety and well-being of everyone involved in mining operations.

Conflict of Interest Statement

The authors agree that this research was conducted in the absence of any self-benefits or commercial or financial conflicts and declare the absence of conflicting interests with the funders.

References

Ajith, M. M., Ghosh, A. K., & Jansz, J. (2020). Risk factors for the number of sustained injuries in artisanal and small-scale mining operation. *Safety and Health at Work*, *11*(1), 50-60. https://doi.org/10.1016/j.shaw.2020.01.001

Ajith, M. M., Ghosh, A. K., & Jansz, J. (2021). A mixed-method investigations of work, government and social factors associated with severe injuries in artisanal and small-scale mining (ASM) operations. *Safety Science*, *138*, 105244. https://doi.org/10.1016/j.ssci.2021.105244

Ameer, S. M., Noraishah, I. S., Azizan, R., & Ratih, D. (2022). Investigation of the factors contributing to unsafe behaviour of iron ore miners in Malaysia. *Current Science and Technology (CST), 2*(1), 30-39. https://doi.org/10.15282/cst.v2i1.7609

Amponsah-Tawiah, K., & Mensah, J. (2016). Occupational health and safety and organizational commitment: Evidence from the Ghanaian mining industry. *Safety and Health at Work*, *7*(3), 225-230. https://doi.org/10.1016/j.shaw.2016.01.002

Atay, E., & Terpstra-tong, J. L. Y. (2020). The determinants of corporate social irresponsibility: A case study of the Soma mine accident in Turkey. *Social Responsibility Journal*, *16*(8), 1433-1452. https://doi.org/10.1108/SRJ-01-2019-0042

Bandura, A. (1977). *Social learning theory*. Prentice-Hall.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Bhattacharjee, R. M., Dash, A. K., & Paul, P. S. (2020). A root cause failure analysis of coal dust explosion disaster – Gaps and lessons learnt. *Engineering Failure Analysis*, *111*, 104229. https://doi.org/10.1016/j.engfailanal.2019.104229

Cooper M. (2000). Towards a model of safety culture. *Safety Science*, *36*(2), 111-136. https://doi.org/10.1016/S0925-7535(00)00035-7

Dursun, A. E. (2020). Statistical analysis of methane explosions in Turkey's underground coal mines and some recommendations for the prevention of these accidents: 2010–2017. *Natural Hazards*, *104*(1), 329-351. https://doi.org/10.1007/s11069-020-04170-x

Fu, G., Xie, X., Jia, Q., Tong, W., & Ge, Y. (2020). Accidents analysis and prevention of coal and gas outburst: Understanding human errors in accidents. *Process Safety and Environmental Protection*, *134*, 1-23. https://doi.org/10.1016/j.psep.2019.11.026

Geller, E. S. (1997). *The psychology of safety: How to improve behaviors and attitudes on the job*. CRC Press LLC.

Geller, E. S. (1994). Ten principles for achieving a total safety culture. *Professional Safety*, *39*(9), 18-24.

Grodzicka, A., & Szlązak, J. (2016). Analysis of survey results in terms of selection of characteristics of the mining rescuer to the ranks of rapid response. *Management Systems in Production Engineering*, *22*(2), 3916, 135-140. https://doi.org/10.2478/mspe-10-02-2016

Guldenmund, F. (2000). The nature of safety culture: A review of theory and research. *Safety Science*, *34*(1-3), 215-257. https://doi.org/10.1016/S0925-7535(00)00014-X

Hizam-Hanafiah, M., Soomro, M. A., & Abdullah, N. H. (2020, July 15). *Industry 4.0 readiness models: A systematic literature review of model dimensions*. https://scite.ai/reports/10.3390/info11070364

Ismail, S. N., Ramli, A., Abdul Aziz, H., Morshidi, A., & Zainal Abidin, M. F. (2023). Establishing an organisational safety culture system in the Malaysian mining industry. *Journal of Business and Social Development*, *10*(2), 73-88. http://doi.org/10.46754/jbsd.2022.09.005

Ismail, S. N., Ramli, A., & Abdul Aziz, H. (2022a). Does expert judgement is important in mining industry?: A systematic literature review study. *Journal of Governance and Integrity*, *5*(2), 249-266. https://doi.org/10.15282/jgi.5.2.2022.7135

Ismail, S. N., & Ramli, A. (2022b). Does human factor contribute to mining accidents? A systematic literature review approach. In *Human-centered technology for a better tomorrow*. Springer Singapore. https://doi.org/10.1007/978-981-16-4115-2_48

Ismail, S. N., Ramli, A., & Aziz, H. A. (2021). Influencing factors on safety culture in mining industry: A systematic literature review approach. *Resources Policy*, *74*, 102250. https://doi.org/10.1016/j.resourpol.2021.102250

Jiang, W., Fu, G., Liang, C-Y., & Han, W. (2020). Study on quantitative measurement result of safety culture. *Safety Science*, *128*(11), 104751. https://doi.org/10.1016/j.ssci.2020.104751

Kalteh, H. O., Mortazavi, S. B., Mohammadi E, & Salesi, M. (2021). The relationship between safety culture and safety climate and safety performance: A systematic review. *International Journal of Occupational Safety and Ergonomics*, *27*(1), 1-31.

Li, K., Wang, L., & Chen, X. (2022). An analysis of gas accidents in Chinese coal mines, 2009–2019. *The Extractive Industries and Society*, *9*, 101049. https://doi.org/10.1016/j.exis.2022.101049

Liu, Q., Dou, F., & Meng, X. (2020). Building risk precontrol management systems for safety in China's underground coal mines. *Resources Policy*, *74*, 101631. https://doi.org/10.1016/j.resourpol.2020.101631

Miao, C. lin, Duan, M. meng, Sun, X. xiu, & Wu, X. yu. (2020). Safety management efficiency of China's coal enterprises and its influencing factors—Based on the DEA-Tobit two-stage model. *Process Safety and Environmental Protection*, *140*, 79-85. https://doi.org/10.1016/j.psep.2020.04.020

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., & The PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine,* *6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Moore, K. R., Moradi, S., Doyle, K., Sydd, O., Amaral, V., Bodin, J., Brito-Parada, P. R., Dudley, F., Fitzpatrick, R., Foster, P., Goettmann, F., Roberts, D., Roethe, R., Sairinen, R., Sambrook, T., Segura-Salazar, J., & Thomas, G. (2021). Sustainability of switch on-switch off (SOSO) mining: Human resource development tailored to technological solutions. *Resources Policy*, 73, 102167. https://doi.org/10.1016/j.resourpol.2021.102167

Murphy, T., Aldossari, H., Birkenbuel, L., Rosenthal, S., Autenrieth, D., McGivern, M., & Gilkey, D. (2021). Safety climate in MT mining: A case study. *Mining, Metallurgy and Exploration, 38*(5), 1861-1875. https://doi.org/10.1007/s42461-021-00472-1

Musonda, I., Lusenga, E., & Okoro, C. (2021). Rating and characterization of an organization's safety culture to improve performance. *International Journal of Construction Management, 21*(2), 181-193. https://doi.org/10.1080/15623599.2018.1512030

Niu, L., & Liu, Y. (2022). The relationship between leadership safety commitment and resilience safety participation behavior. *Psychology Research and Behavior Management, 15*, 517-531. https://doi.org/10.2147/PRBM.S349712

Noraishah, S., Ramli, A., & Abdul, H. (2021). Research trends in mining accidents study: A systematic literature review. *Safety Science*, *143*, 105438. https://doi.org/10.1016/j.ssci.2021.105438

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*(1), 1-13. https://doi.org/10.1177/1609406917733847

Ochoa Pacheco, P., Cunha, M. P. e., & Abrantes, A. C. M. (2022). The impact of empowerment and technology on safety behavior: Evidence from mining companies. *International Journal of Occupational Safety and Ergonomics, 28*(1), 581-589. https://doi.org/10.1080/10803548.2020.1808343

Owoeye-Lawal, OT., Kareem A. O., Aro, AJ., Kareem, AJ., Lawal, OA., & Adewale, Aro (2022). Risk factors for occupational injuries among solid mineral miners in OSE local government of Ondo State, Nigeria. *International Journal of Occupation Safety and Health*, *12*(3), 144-151. https://www.nepjol.info/index.php/IJOSH/article/view/40264

Patyk, M., & Nowak-Senderowska, D. (2022). Occupational risk assessment based on employees' knowledge and awareness of hazards in mining. *International Journal of Coal Science and Technology, 9*(1), 1-11. https://doi.org/10.1007/s40789-022-00554-5

Rahimdel, M. J., Aryafar, A., & Vaziri, S. (2022). Fuzzy FMEA for the safety risk analysis of underground coal mining (a case study in Iran). *Mining Technology: Transactions of the Institute of Mining and Metallurgy, 131*(2), 104-114. https://doi.org/10.1080/25726668.2022.2051273

Reason, J. (1997). *Managing the risks of organizational accidents*. Ashgate, Aldershot.

Reniers, R. L. E. P., Corcoran, R., Drake, R., Shryane, N. M., & Völlm, B. A. (2011). The QCAE: A questionnaire of cognitive and affective empathy. Journal of Personality Assessment, 93(1), 84-95. https://doi.org/10.1080/00223891.2010.528484

Rose, R. L., Mugi, S. R., & Saleh, J. H. (2023). Accident investigation and lessons not learned: AcciMap analysis of successive tailings dam collapses in Brazil. *Reliability Engineering and System Safety, 236*, 109308. https://doi.org/10.1016/j.ress.2023.109308

Rubin, M., Giacomini, A., Allen, R., Turner, R., & Kelly, B. (2020). Identifying safety culture and safety climate variables that predict reported risk-taking among Australian coal miners: An exploratory longitudinal study. *Safety Science*, *123*, 104564. https://doi.org/10.1016/j.ssci.2019.104564

Schein, E. H. (1992). *Organizational culture and leadership second edition*. United States: Jossey-Bass.

Schein, E. H. (1996). *Organizational learning: What is new?* Working paper 3912.

Talukder, B., VanLoon, G. W., Hipel, K. W., & Orbinski, J. (2021, January 1). *COVID-19's implications on agri-food systems and human health in Bangladesh*. https://scite.ai/reports/10.1016/j.crsust.2021.100033

Tonasa, P. T. S., Wahyu, A., Suwandi, T., Basuki, H., & Mallongi, A. (2020). Model development of behavior-based safety in workplace based on religiosity and psychological condition of workers at PT Semen Tonasa. *Open Access Macedonian Journal of Medical Sciences, 8*, 474-480.

Tong, D. Y. K., Rasiah, D., Tong X. F., & Lai, K. P. (2015). Leadership empowerment behaviour on safety officer and safety teamwork in manufacturing industry. *Safety Science, 72*, 190-198. https://doi.org/10.1016/j.ssci.2014.09.009

Tong, R., Yang, X., Li, H., & Li, J. (2019). Dual process management of coal miners' unsafe behaviour in the Chinese context: Evidence from a meta-analysis and inspired by the JD-R model. *Resources Policy*, 62, 205-217. https://doi.org/10.1016/j.resourpol.2019.03.019

Wang, X., Zhang, C., Deng, J., Su, C., & Gao, Z. (2022). Analysis of factors influencing miners' unsafe behaviors in intelligent mines using a novel hybrid MCDM model. *International Journal of Environmental Research and Public Health, 19*(12), 7368. https://doi.org/10.3390/ijerph19127368

Wu, Y., Chen, M., Niu, L., Qiu, P., & Zhou, A. (2020). A new safety supervision model for underground coal mines in China. *Energy Sources, Part A: Recovery, Utilization and Environmental Effects*, 1-15. https://doi.org/10.1080/15567036.2020.1804486

Wu, T., Lin, C., & Shiau, S. (2010). Predicting safety culture: The roles of employer, operations manager and safety professional. *Journal of Safety Research*, *41*(5), 423-431. https://doi.org/10.1016/j.jsr.2010.06.006

Xie, X., Hu, J., Fu, G., Shu, X., Wu, Y., Huang, L., & Shen, S. (2023). Investigation of unsafe acts influence law based on system dynamics simulation: Thoughts on behavior mechanism and safety control. *International Journal of Environmental Research and Public Health, 20*(6). https://doi.org/10.3390/ijerph20064733

Yorio, P. L., Haas, E. J., Bell, J. L., Moore, S. M., & Greenawald, L. A. (2020). Lagging or leading? Exploring the temporal relationship among lagging indicators in mining establishments 2006–2017. *Journal of Safety Research*, *74*, 179-185. https://doi.org/10.1016/j.jsr.2020.06.018

Yuan, Q., Zhang, X., Zhu, H., Zhang, B., & Chen, J. (2023). Research on influencing factors of coal mine safety production based on integrated fuzzy DEMATEL-ISM methods. *Energy Sources, Part A: Recovery, Utilization and Environmental Effects, 45*(1), 2811-2830. https://doi.org/10.1080/15567036.2023.2192012

Zhang, J., Fu, J., Hao, H., Fu, G., Nie, F., & Zhang, W. (2020). Root causes of coal mine accidents: Characteristics of safety culture deficiencies based on accident statistics. *Process Safety and Environmental Protection, 136*, 78-91. https://doi.org/10.1016/j.psep.2020.01.024

Zujovic, L., Kecojevic, V., & Bogunovic, D. (2020). *Application of a content management system for developing equipment safety training courses in surface mining*. https://scite.ai/reports/10.17159/2411-9717/1233/2020