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Cover Page Footnote

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Prospective study on safety climate of surface mining in Pakistan

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Abstract

The purpose of this study was to assess miners' perceptions about the safety climate of their workplace. To achieve the research aim, the relationship between demographic characteristics and occupational hazards was first determined, and finally, the relationship of safety climate with occupational hazards and health-seeking behavior was discovered. The data was collected through a self-reporting questionnaire. The results revealed that the subjects have to deal with severe occupational hazards, and they possess poor health-seeking behavior. A safety climate assessment showed that only one of the seven dimensions (i.e. *safety communication, learning, and trust in co-worker safety competence*) was at a satisfactory level. With respect to the first objective, we found that age, education, and experience were statistically significant with occupational hazards, while marital status had no significant impact on occupational hazards. Regarding the second objective, three dimensions (*management safety justice*, *safety communication, learning, and trust in co-worker safety competence*, and *workers' trust in the efficacy of safety systems*) were significant predictors of occupational hazards. The study reflects that workers' participation is the main factor in setting up an adequate safety climate within the organization. Suggestions provided in this study could provide useful information to managers and safety practitioners to improve safety performance and promote the safety climate in the organization.

Keywords: safety climate, occupational hazards, mineworkers, surface mining, mine health and safety

1. Introduction

Mining is one of the most dangerous industries in the world because it involves workers in dangerous conditions and exposes them to an increased risk of accidents. Pakistan's mining industry is subjected to many constraints, such as low socioeconomic status, lack of legislation, poor working conditions and lack of safety measures [1,2]. The industry is also not technologically advanced, so considerable attention should be paid for achieving sustainable economic growth through intelligent planning for the exploitation of indigenous mineral resources [2–4]. Due to the unregulated nature of the mining industry, there is a long history of accidents and health complaints, which have not yet been resolved. Safety is a key component of sustainable mining practices, due to its implications for cost, delivery, quality, and social responsibility. Therefore, in order to maintain the sustainability of the mining industry, all mining activities must be carried out safely.

Hazardous environments and underestimation of safety risks are common problems in the industry, which can both lead to serious safety incidents. Poor health and safety practices, as well as mental stress and job insecurity, can also increase the risk of accidents [5,6]. In this context, the issue of workplace

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safety is highly relevant, as the risk of occupational hazards may have a negative impact on the future perceptions of safety climate [7]. Occupational health and safety management is an important aspect because it aims to adapt workers to their working environment in order to promote and maintain their well-being [8]. Compared with workers in other fields, mineworkers face relatively dangerous working environments [9]. In-depth investigations found that the safety awareness of mineworkers can be improved by reducing their unsafe behaviors [10].

Safety climate assessment is regarded as an emerging research field to address the demand for improvement in safety performance. In the 21st century, this field has dramatically developed and received more attention, and its research and practice have also achieved fruitful results [11]. Safety climate is the shared views on policies, procedures, and practices related to organizational safety. In short, a safety climate reflects employees' perception of the true value of organizational safety, which is a factor in reducing accidental injuries [12]. Researchers have developed many diagnostic tools to measure the status and progress of the safety climate within an organization. However, active monitoring of a variable that has proven to be a leading indicator of various safety outcomes remains a critical phase. Investigating and controlling the safety climate in the workplace plays an essential role in preventing accidents and improving the level of safety production. It can also significantly help enterprises identify hazards in the system and actively prevent the risks of accidents. Strengthening safety culture creates economic benefits, encourages employees to participate in safety management, and prevents mine accidents [13]. A study revealed that a low safety climate, in turn, impacts negatively on performance [14]. Research shows that management plays a vital role in shaping workers' behavior in the workplace. The perceived level of safety climate is related to the perceived mutual commitment between workers and their supervisors [15]. It can be said that enhancing safety in work has effectively reduced the number of workplace accidents. However, research also shows that many new occupational diseases are increasing year by year. For this, some countermeasures are also put forward to enhance the wellbeing of miners and reduce their unsafe behaviors [16]. Training, together with a strong safety culture, safety communication, and leadership skills, may help to produce the desired work safety behavior [17]. At present, technology and equipment can help create a safer working environment to achieve the goal of zero accidents in the workplace [18].

This study analyzed mineworkers' perceptions of the safety climate of the surface mining industry in Pakistan. Two objectives were set for this study: (a) to find a relationship between demographic characteristics and occupational hazards; (b) to discover whether there is any relationship between the safety climate, and occupational hazards and preventive health measures. In addition, the study will guide management to set up a favorable safety climate and provide workers with an opportunity to reflect their safety motivations and safety choices. This research contributes to the existing literature because there are few studies on the safety climate of the mining industry, especially in Pakistan.

2. Methodology

The safety climate was assessed through a cross-sectional survey using a previously validated Nordic Safety Climate Questionnaire (NOSACQ-50), developed by [19]. The questionnaire consists of 50 items, divided into seven dimensions. These dimensions are shared perceptions of: management safety priority, commitment, and competence (D1); management safety empowerment (D2); management safety justice (D3); workers' safety commitment (D4); workers' safety priority and risk non-acceptance (D5); safety communication, learning, and trust in co-worker safety competence (D6); and workers' trust in the efficacy of safety systems (D7). This diagnostic tool was chosen because it allows more specific identification of areas of the organization that need improvements. It is based on the 4-point Likert scale, which excludes neutral statements, which may have a negative impact on the outcome of the assessment. The questionnaire has both positively and negatively (reversed) formulated items.

Data from 108 male workers involved in surface mining operations who agreed to take part in the study was collected using the convenience sampling method. Most of the participants were illiterate and unable to fill out the questionnaire. Therefore, the questions were read and explained to them, and then the questionnaire was completed by one of the authors interviewing them. The anonymous survey consists of questions on demographic characteristics, occupational hazards, and preventive health measures. The participants were asked to rate the extent to which they considered an item to be a serious hazard. Responses for hazard seriousness

Table 1. Demographic data of the participants.

Variable	Description	Frequency (%)
Age (years)	18–33	38 (35.2)
	34–49	37 (34.3)
	≥50	33 (30.6)
Marital status	Single	24 (22.2)
	Married	82 (75.9)
	Other	2 (1.9)
Education level	Uneducated	56 (51.9)
	Primary	38 (35.2)
	Secondary	14 (13.0)
Total experience (years)	≤5	37 (34.3)
	6–10	51 (47.2)
	≥11	20 (18.5)

and the frequency with which it occurred, ranged from 1 – very low to 5 – very high.

The data from the questionnaire survey was coded in SPSS v23 by assigning corresponding values to various responses for analysis. The demographic characteristics, exposure to occupational hazards and preventive health measures were characterized using frequencies and percentages. The score of each dimension for NOSACQ-50 was analyzed and explained according to published guidelines. Pearson's Chi-square test at a 5% significance level was used to discover the relationship between variables.

3. Results

The demographic data of the participants is presented in Table 1. From all the survey respondents, 35.2% were between 18 and 33 years old, 75.9% were married, more than half of the participants (51.9%) were uneducated, and 47.2% had 6–10 years of work experience.

3.1. Occupational hazards

The results shown in Table 2 describes the extent to which participants perceived themselves exposed to occupational hazards. According to statistics, it can be assumed that the workplace was hazardous. This is clarified by 71.3% of participants who experienced pain/disorders in the body. The two most commonly reported hazards in this survey were the lifting and handling of heavy loads (35.2%) and falling from height (22.2%). Most participants, while on duty, were suffering from occupational diseases (27.8%). Participants rated the severity level of harms and hazards as; minor (38%), moderate (25.9%) and serious (36.1%). The presence of these hazards may not only pose a considerable threat to the health of the workers but may also affect the cost of the project.

Table 2. Participants' perception of occupational hazards.

Hazard	Frequency (%)				Mean (SD)
	18–33	34–49	≥50	Total	
Pain/disorder in body parts	23 (21.3)	24 (22.2)	30 (27.8)	77 (71.3)	1.713 (0.454)
Fractures	6 (5.6)	7 (6.5)	9 (8.3)	22 (20.4)	1.204 (0.405)
Occupational disease	6 (5.6)	8 (7.4)	16 (14.8)	30 (27.8)	1.278 (0.450)
Struck by objects	2 (1.9)	2 (1.9)	3 (2.8)	7 (6.5)	1.065 (0.247)
Lifting and handling heavy loads	20 (18.5)	11 (10.2)	7 (6.5)	38 (35.2)	1.352 (0.480)
Falls from height	9 (8.3)	6 (5.6)	9 (8.3)	24 (22.2)	1.222 (0.418)
Slips/trips	4 (3.7)	7 (6.5)	6 (5.6)	17 (15.7)	1.157 (0.366)
Falling rock block	1 (0.9)	9 (8.3)	4 (3.7)	14 (13)	1.130 (0.337)
Others	2 (1.9)	2 (1.9)	4 (3.7)	8 (7.4)	1.074 (0.263)
Severity					1.981 (0.864)
Minor	19 (17.6)	13 (12)	9 (8.3)	41 (38)	
Moderate	9 (8.3)	10 (9.3	9 (8.3)	28 (25.9)	
Serious	10 (9.3)	14 (13)	15 (13.9)	39 (36.1)	

Table 3. Responses to questions regarding preventive health measures.

Item	Frequency (%)				Mean (SD)
	18–33	34–49	≥50+	Total	
Use of proper tools and machinery	4 (3.7)	8 (7.4)	12 (11.1)	24 (22.2)	1.222 (0.418)
Use of safety equipment	3 (2.8)	2 (1.9)	8 (7.4)	13 (12)	1.120 (0.327)
Safety and health trainings	2 (1.9)	2 (1.9)	4 (3.7)	8 (7.4)	1.074 (0.263)
Trained in first aid	0 (0)	1 (0.9)	2 (1.9)	3 (2.8)	1.028 (0.165)
Emergency services available	2 (1.9)	1 (0.9)	3 (2.8)	6 (5.6)	1.056 (0.230)
Sought treatment while injured	0 (0)	0 (0)	3 (2.8)	3 (2.8)	1.028 (0.165)

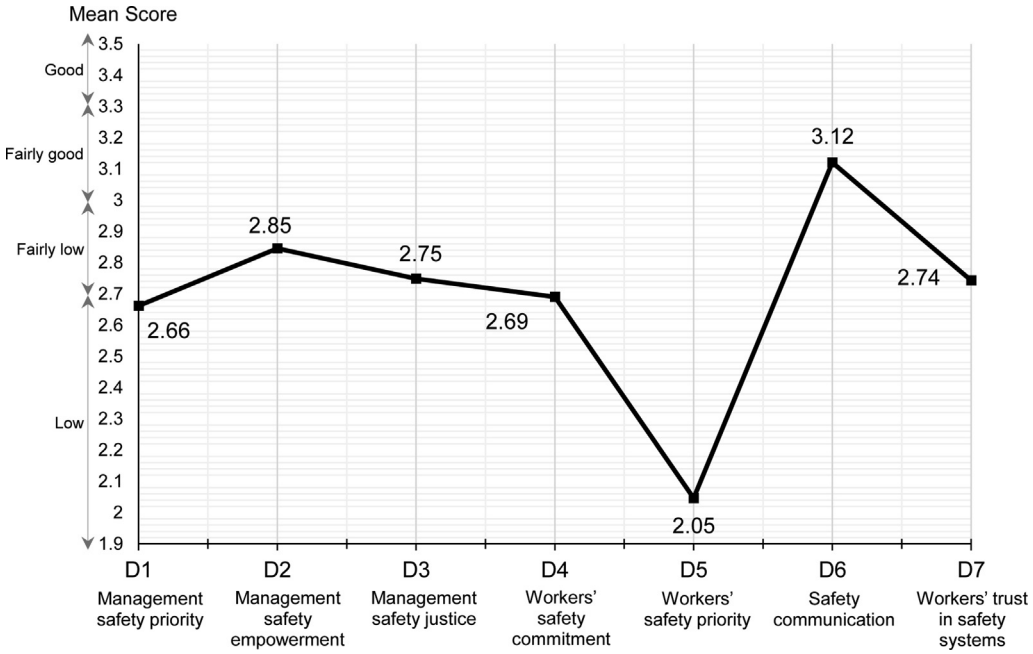

Fig. 1. Scores of seven dimensions of safety climate.

3.2. Preventive health measures

Participants' perceptions of preventive health measures are shown in Table 3. The results indicate that the participants' perspective on the preventive health measure was low, and they had poor health-seeking behavior. A total of 77.8% of the participants were not using proper tools and equipment for their jobs, 88% were not provided with safety equipment, and 92.6% were not trained in health and safety precautions. Many participants (97.2%) reported that they did not receive training in first aid methods and practices. Only 7.4% of the participants reported that they had received health and safety prevention training. Only 2.8% of the participants reported that they were trained to offer first aid in case of emergencies.

3.3. Safety climate

The results provided in Fig. 1 show scores of seven dimensions of safety climate. It gives an indication of how employees perceived and experienced safety in the workplace. There was only one dimension (*safety communication, learning, and trust in co-worker safety competence*) at an appropriate level, while three dimensions (*management safety empowerment*, *management safety justice*, and *workers' trust in the efficacy of safety systems*) were at a fairly satisfactory level of safety climate, which should be slightly improved. The remaining three dimensions (*management safety priority, commitment, and competence*, *workers' safety commitment*, and *workers' safety priority and risk non-acceptance*) were at a low level and required a great need for improvement. The

Table 4. The results of Pearson's chi-square test for the relationship between demographic characteristics and occupational hazards.

Hazard	Age	Marital Status	Education	Experience
Pain/disorder in body parts	0.011*	0.579	0.139	0.000*
Fractures	0.47	0.524	0.004*	0.002
Occupational diseases	0.005*	0.351	0.049*	0.047*
Struck by objects	0.766	0.863	0.000*	0.024*
Lifting and handling heavy loads	0.015*	0.124	0.144	0.000*
Falls from height	0.52	0.726	0.009*	0.082
Slips/trips	0.546	0.000*	0.056	0.579
Falling material	0.020*	0.729	0.001*	0.214
Other	0.463	0.712	0.258	0.666
Severity	0.346	0.643	0.000*	0.030*

*Significant at $p < 0.05$.

Table 5. Association between study variables and safety climate using Pearson's chi-square test.

Dimension	Occupational hazard	Preventive health measure
Management safety priority, commitment, and competence	0.992	0.063
Management safety empowerment	0.767	0.002*
Management safety justice	0.000	0.151
Workers' safety commitment	0.397	0.248
Workers' safety priority and risk non-acceptance	0.499	0.075
Safety communication, learning, and trust in co-worker safety competence	0.019*	0.002*
Workers' trust in the efficacy of safety systems	0.000*	0.383

*Significant at $p < 0.05$.

dimension with the highest value was *safety communication, learning, and trust in co-worker safety competence* (3.12), while the dimension with the lowest value was *workers' safety priority and risk non-acceptance* (2.05). From the results, the general level of safety climate can be considered as low, because the average scores of dimensions were between 2.05 and 3.12 and, therefore, are negative results. These pilot study findings indicate that it is necessary to strengthen the safety policy to improve the safety climate in the industry. An interesting finding was that 34.3% of this convenience sample had less than six years of experience, which could have an impact on their understanding of safety and, therefore, could affect the safety climate. These findings are not generalizable due to sample limitations. However, the results indicate that there is a problem that requires further investigation across the sector in Pakistan.

3.4. Relationship between demographic characteristics and occupational hazards

Table 4 presents the results of Pearson's Chi-square test for the relationship between demographic characteristics and occupational hazards. It was found that age is strongly associated with the hazards of pain/disorder in body parts, occupational diseases, lifting and handling loads, and falling material. Education was another significant factor related to occupational hazards concerning fractures, occupational diseases, being struck by objects, falling from height, and falling material. Whereas, lack of experience was a significant factor when it comes to pain/disorder in body parts, fractures, occupational diseases, struck by objects, lifting and handling heavy loads and the severity of the hazards. In prior studies, it was reported that age and experience could also impact occupational health and safety outcomes [20,21]. However, results did not show any other significant relationships between marital status and occupational hazards, only hazards caused by slips/trips were found to be significant. In general, older workers are more experienced and familiar with working conditions, but this also means that their role involves more responsibilities and risks. They may experience age-related physical and psychological changes that affect their performance and expose them to potential harm [22,23].

3.5. Relationship between safety climate and study variables

Table 5 shows the statistical results of the relationship between safety climate, occupational hazards, and health-seeking behavior. These results show a positive correlation. It was discovered that occupational hazards were significant with three dimensions of the safety climate, namely *management safety justice*, *safety communication, learning, and trust in co-worker safety competence*, and *workers' trust in the efficacy of safety systems*. The preventive health measures of participants were found to be significant for only two dimensions, i.e. *management safety empowerment*, and *safety communication, learning, and trust in co-worker safety competence*. These results lead to an important conclusion about the relationships that the presence of workplace hazard affects the overall safety climate. It suggests that these issues require immediate managerial intervention.

4. Discussion

This descriptive study was conducted to assess mineworkers' perceptions of the safety climate within the surface mining industry in Pakistan. A survey method was adopted to investigate the various aspects of safety in surface mining. The research framework adopted in this study found to be valuable for assessing workers' perceptions of safety climate. The results suggest that the nature of the job and the workload of a worker are among the key issues to address safety in the mining sector, but education and safety awareness also have a significant impact. Previous research has shown that job tenure is associated with greater job performance because, over time, workers gain more tacit

knowledge and can more effectively perform their jobs [24–26]. The analysis of occupational health and safety hazards experienced by workers shows that these hazards may pose risks for injury or illness or may cause accidents. These accidents and injuries caused by these hazards can also have a predictive effect on safety climate [27]. The most frequently reported hazard by participants was pain/disorder in the body, referred to as musculoskeletal symptoms. In the U.S. logging industry, workers with musculoskeletal symptoms were more likely to have low safety priorities and accept risks in the workplace, which results in a low safety climate [28]. The other hazards involved in work were specified as the lifting and handling of heavy loads, falling from height, and occupational diseases. Manual material handling and fall prevention should be a major priority in order to alleviate the suffering of the individual worker, and industrial losses [29]. The analysis of participants' perspectives on the preventive health measure was low, and they had poor health-seeking behavior. They were not provided with the proper tools and equipment for their job and safety equipment. Most of them were not trained in health and safety precautions. These findings support the view that an employee's safety compliance and participation can be achieved through a positive safety climate. Specialized behavior-based training is an important tool that changes the behavior of mineworkers towards safety climate [30–32]. The analysis of safety climate shows that *safety communication, learning, and trust in co-worker safety competence* was the only dimension at an appropriate level. Whereas, *management safety empowerment*, *management safety justice* and *workers' trust in the efficacy of safety systems* were at a satisfactory level. However, workers also perceived three dimensions to be low, namely, *management safety priority, commitment, and competence*, *workers' safety commitment*, and *workers' safety priority and risk non-acceptance*. According to the average results of seven dimensions of safety climate, it can be said that the surface mining industry possesses a low safety climate. It is, however, important to remember that the current study is not based on a representative sample. From our survey, 34.3% of the participants had less than six years of experience in mining; one hypothesis could be that they may have no or less experience of other safety cultures and safety climates. The findings showed that age, education, and experience were statistically significant with regard to most hazards. In prior research, it was reported that age and experience could also affect occupational health and safety outcomes. The performance of experienced workers can be affected by their long exposure to potential harms [22,23]. The results of the relationship between safety climate, occupational hazards and health-seeking behavior show a positive correlation. The analysis showed the relationship of occupational hazards with *management safety justice*, *safety communication, learning, and trust in co-worker safety competence* and *workers' trust in the efficacy of safety systems.* While the relationship between preventive health measure, *management safety empowerment* and *safety communication, learning, and trust in co-worker safety competence* were also found in this study. Management commitment and attitude is an important dimension of workers' perception [33]. In recent years, it has become accepted that factors contributing to occupational health and safety incidents are related to the organizational risk management practices that are in place within the work environment [34]. [35] determined that the probability of incident reoccurrence is substantial after one's first injury. They suggested that more effective prevention measures should be put in place on a routine basis. Improving the safety climate, which focuses on commitment, involvement, and accountability can have a substantial impact on improving employee safety and reducing the frequency of the hazard occurrence as well as improving the viability of the organization. The presence of workplace hazards affects the overall safety climate. The findings from our study support one of the previous studies that states that job hazard has a direct impact on work injury [32]. This shows that these issues require immediate managerial intervention.

5. Conclusions

The participants' perception of workplace safety was illustrated through a cross-sectional survey aimed at determining the current level of safety climate. The results revealed that participants deal with severe occupational hazards, and they possess poor health-seeking behavior. The results of this study show that workers' perception of the safety climate of their workplace is very low. Therefore, it is necessary to formulate innovative approaches to reduce the risk of accidents, while at the same time ensure sustainable mining. This study provides some notable implications for workplace safety management in occupational health and safety issues to prioritize safety within the workplace. First, the mining sector needs effective management to improve safety within the organization. Authorities should ensure that both employers and employees comply with health and safety regulations and treat occupational health and safety issues as a collective

responsibility to make the work environment safer. Management should put in place a mandatory safety program consisting of an integrated approach of education, enforcement, and engineering controls. The workforce should be provided with adequate protective tools, aid equipment, reasonable working conditions, and a clean and healthy work environment. It should be ensured that mining activities are updated and that work conforms to laws and regulations to improve human and environmental safety. Secondly, management and workers should consider safety to be a collaborative responsibility to improve working conditions. The outcomes of this study could be useful when applying resources and focusing on the appropriate areas in order to make safety improvements in the workplace.

Conflicts of interest

None declared.

Ethical statement

The authors state that the research was conducted according to ethical standards.

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